(Second Series) Vol. 1.—No. 2.

Western Australia.

JOURNAL

OF THE

DEPARTMENT OF AGRICULTURE

OF

WESTERN AUSTRALIA.

By Direction of

The HON. THE MINISTER FOR AGRICULTURE.

PUBLISHED QUARTERLY.

JUNE, 1924.

PERTH:
BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.
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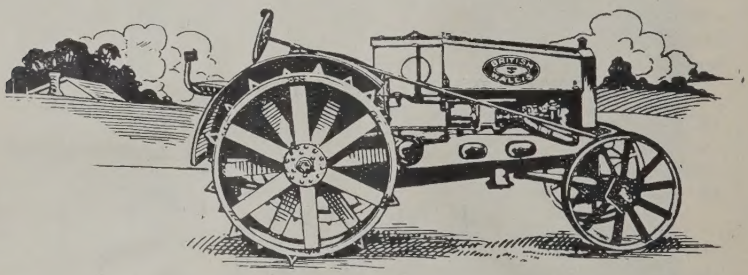

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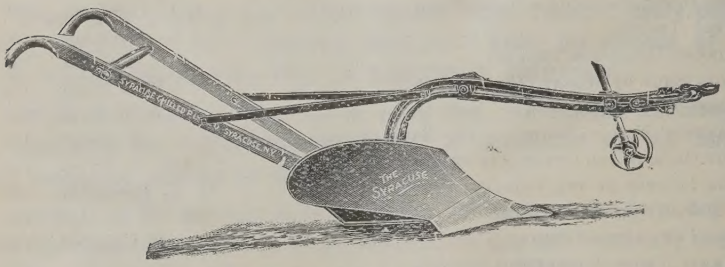

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Vol. 1. (Second Series) JUNE, 1924. No. 2.

THE FARM HORSE: HINTS ON FEEDING.

A. McK. Clark, L.V.Sc.

Acting Chief Inspector of Stock.

The feeding of the Farm Horse is a matter of great economic importance, as it is intimately connected with the production of disease or the preservation of health. The farmer on the wheat belt is in a very happy position insomuch that he has no infectious or contagious diseases to contend with. Also hand feeding and the cultivation of pastures eliminates the possibility of plant poisons. It should naturally follow that the mortality would be low, but this is not so, as the deaths reach a greater proportion than should be the case. This is attributed, therefore, to insufficient care in the feeding of these animals. It is with the object of minimising this particular wastage that I wish to deal with the general principles involved in correct feeding, so that those who are apt to consider the feeding of the horse as of little consequence as regards its health, may be enlightened. Correct feeding is an art which comes naturally to the horse lover and keen observer, whilst it is never acquired by the person who looks upon this animal as a mere slave.

When looking at this matter from a plain and practical standpoint, one needs only to go into the nutritive values of foodstuffs superficially, and in doing so deal with the rations available and commonly used on the average farm, namely, chaff, bran, oats, green foods, and stubble.

Chaff, bran, and oats, if used correctly, are all that is required to maintain perfect health and produce the energy necessary for the working horse.

Chaff.—This may be wheaten or oaten, cut for the purpose of avoiding waste, blending with the supplementary ration and aiding mastication. Oaten chaff is the more nourishing of the two. A good sample of chaff is equal to one-third the value of good oats, whilst some inferior samples are only the

value of straw. The farmer generally is apt to over estimate the value of chaff as a ration. It is too bulky a ration to feed solely to working horses. The quantity required to maintain condition and provide the necessary energy is so great that the capacity of the bowels is overtaxed while endeavouring to accommodate such. The stomach is distended, leading to pressure on the diaphragm and consequent interference with the breathing apparatus. Extra work is also thrown on the digestive system, and retarding of assimilation results. An illustration of this is only too often seen in the pot-bellied, wasted muscle, short-winded, and constitutionally weakened plough horse. This animal is a fit subject for colic, and apart from the risk of loss through death, a loss of power results. These two factors can be obviated by an alteration in diet. Replace a quantity of the chaff by a more concentrated ration, such as oats. If the oats are of good quality, every one pound substituted for every two pounds of chaff would provide an excess of nourishment and a decrease of bulk. At the same time too great a reduction in the chaff should not be practised, as bulk is essential as an aid to digestion. The alteration of the diet should be based on the principle that the harder the work performed the greater should be the amount of concentrates added. The idle horse can be fed on a fair averaged sample of chaff without risk.

Oats.—Of all grains, oats represent one which is essentially a horse food, on account of its being easily digestible and its constituents being so evenly balanced. A good oat should be short and plump. Oats are fed bruised or whole. While the former are best for horses which are debilitated or have defective teeth, crushing is not necessary, as digestion is not aided by this in the normal horse. The nutritive value of the best oats as compared with good quality chaff should be regarded for practical purposes as one pound of oats to three pounds of chaff.

Bran.—This consists of two kinds, fine and coarse; the former is termed pollard and the latter bran. Salts are excessive in bran, and the nutritive value is a matter of question. As a health producer it is almost essential where green feed is not available, and for this purpose should be used wherever possible. It is laxative in its effects, and for this purpose, if not given in small quantities for the working horse daily, should be given as a week-end ration; but not more than three pounds should be fed at the one time. As a week-end ration, it may be given with advantage as a mash Where dry hay or stubble is the main diet for the spelling horse, it should be supplied at least once a day with a little chaff and bran.

Stubble.—The practice of turning the horse out on stubble when harvesting is completed, without a supplementary ration, often leads to disastrous results. This diet, owing to its dry fibrous character, brings about a loss of tone in the muscular wall of the bowels, and they become inactive. Sand, which is taken up in the pastures, is not expelled, nor are parasites, which are common in the horse. The supply of bran, at least once a day, in this case will maintain the normal condition of the bowels, and also produce that laxative effect which is required to expel the greater proportion of sand and worms.

Green Food.—This should always be supplied in small quantities, when available, to the working horse, and may replace bran; whilst the idle horse is maintained solely on grasses which, when matured, are a perfect health restorer.

The Combined Ration.—The daily ration for a working farm horse should be approximately 15lbs. chaff, 10lbs. oats, and 2lbs. bran. In the case of idle horses the oats may be withdrawn altogether and replaced with increased quantity of chaff. The art of successful rationing can only be acquired by close observation. The characteristics of each horse should be closely watched. Some are rapid feeders, whilst some are slow. Some are large eaters, while some eat little. All these things should be taken into consideration, and measures adopted to create conditions as near normal as possible. Those that require more food should be given it, and those which are slow eaters should be given longer time to eat it. Rapid eaters should be prevented from bolting their food by placing a few stones in the mangers. In order to control those conditions, horses should be fed separately. The horse has comparatively a small stomach, and one which is easily distended if over fed. For this reason they should not be allowed to go for too long an interval between feeding. The practice to adopt always is to give small feeds and often, and one which will be completely eaten up at each meal. Under normal conditions feeding should be carried out at regular intervals, such as 6 a.m., 12 noon, 5 p.m., and 10 p.m. Do not work a horse immediately after a meal, but allow him ample time to digest a portion of it. A change of diet always requires careful attention. Colic very often supervenes when horses are brought in from pastures and suddenly changed on to hard working diet. For this reason the change should be made gradually, by giving small feeds to commence with. A safe procedure to adopt is to bran-mash the animals for the first couple of days immediately following their return to the stables. Do not put horses to work for at least four days after the change of diet takes place.

Watering.—Pure water is just as necessary for stock at it is for man. For this reason well water supplied out of troughs or a running stream is always best. Dam water which has become polluted is dangerous, as it harbours parasitic infection. Horses are particularly prone to parasitic infection. Wherever possible dams should be fenced in and provided with a mill and trough. Always water before feeding. This should be observed on account of the small stomach of the horse, for if watered after feeding the flush of water will remove undigested food to the more delicate portions of the intestines, where it will cause irritation of those parts, and subsequent colic. When working, no harm is done in watering horses whenever possible. This will prevent the sudden ingestion of a large quantity of cold water, and resulting chills and colic.

MINERALS AND THE HEALTH OF CATTLE.

A. B. ADAMS, Dipl. Agr.

Agricultural Adviser, Dairy Branch.

It is only comparatively recently that the importance of the mineral constituents of food has been realised, and that experiments have been made to see what quantities are actually required and under what conditions minerals are absorbed by and lost from the animal system. The oldest authorities on feeding, laid stress on a balanced ration and insisted on the importance of correct proportions of albuminoids, carbohydrates and fat, but the necessity of a sufficiency of minerals, and a proper ratio of these minerals themselves, if not lost sight of was not given much importance.

The chief minerals required by the animal are Potash, Soda, Lime and Magnesia, in the form of Phosphates, Fluorides, Chlorides and Carbonates. In this article it is proposed to discuss the Lime (CaO) and Phosphoric Acid (P_2O_5) required, these being the substances usually in the shortest supply. Minerals are required by the growing animal for the formation of bone. In normal bone, the proportion of phosphorus pentoxide (P_2O_5) to lime (CaO) are as 1 : 1.5, and as Phosphorus is required in the formation of other tissues, it appears reasonable to assume that these minerals should be present in the food in at least equal proportions. As cow's milk, which is an ideal food for the young animal, contains these two minerals in equal proportions, it would appear that this proportion is correct.

The growing animal requires these minerals in larger amounts for the formation of the skeleton and more than a mature animal for other tissues. While suckling or receiving ample supplies of milk, a sufficiency is obtained from this source; after weaning, mineral requirement must be obtained from the food. Should there be an acute deficiency, the growing animal generally develops thickened joints, and is malformed, but should the deficiency be slight, the result will be that the animal will not thrive or make as big a frame as it otherwise would do.

In a South African experiment ("S. African Jour. of Agric.," Vol. IV., No. 5) with calves averaging 300lbs. in weight (April, 1921), after three months' feeding with bone meal these calves weighed 60lbs. more than controls without bone meal. By November they were 80lbs. heavier, thus not only maintaining their lead, but actually increasing slightly in weight during the period in which the control animals were losing weight on the poor winter pasture. With the return of good grazing, they increased in weight at a greater rate than the controls, and at the end of April, 1922, were worth 50 per cent. more than those which had not received bone meal.

The dairy cow has also a very high mineral requirement, as her milk has to supply the calf with material for bone formation.

Kellner estimates for a fattening ox of 1,000lb. live weight that 1oz. phosphorus pentoxide and 2oz. lime per day, and for full-grown fattening sheep of 1,000lb. live weight, .02oz. and .2oz. respectively are sufficient. With growing animals, these amounts are probably far too small.

In the case of the dairy cow, the following figures will give an approximate idea of the amount required:—

Over a number of analyses, the minimum amount of ash in milk was 0.75 per cent., and this ash contained as a minimum 22.4 per cent. P_2O_5 and 19.7 per cent. CaO.

A cow giving 3 gallons of milk per day, will, therefore, require for the supply of phosphorus pentoxide and lime in the milk, at the lowest estimate, 6oz. and 5oz. a week respectively. Her own requirements for maintenance will be equal to those of a fattening ox, so that a cow of 7cwt. will require a further .75oz. P_2O_5 and 1.5oz. CaO per day. Should she be in calf, there will be a further drain to supply the bones and tissues of the fœtus. Therefore, a cow of 750lbs. live weight will require at least 1.6oz. P_2O_5 and 2.25oz. CaO per day.

Symptoms of a Deficiency.

Should the feed be deficient in the requisite minerals, certain well marked symptoms usually follow.

(a) The earliest general symptom is bone chewing or osteophaga. A beast will hunt around for bones and on finding one, will stand chewing it for a long time. Occasionally cattle get the habit when short of minerals and will continue it when the deficiency is not so marked, but it is improbable that cattle will continue to chew bones when they are getting an ample supply of minerals in their feed.

(b) If the shortage is very acute, cattle develop what is known as allotrophaga, a craving for unnatural substances, and will chew harness, boots, bags, clothing, deal board and even old tins.

(c) A further sympton which soon follows, if it does not accompany (b) at the start, is a stiffness or cramp, usually most pronounced in the fore limbs, and arched back. The animal is usually poor in condition, but in most cases, the eye is bright and the noise moist. Although in W.A. the stiffness is almost invariably in the fore limbs, in N.S.W. (Dep. of Agric. of N.S.W. Science Bulletin No. 12) the cattle affected are stated to be stiff in the hind limbs in the majority of cases.

Cattle that have been running on soils deficient in available phosphates, on being examined after death, are often found to have lumps on the ribs, as if these bones had been broken at some time.

The season when above symptoms, especially (c), are usually most noticeable is during or at the end of summer, when the clover is all done and there is no green food.

Troubles caused by the deficiency.

The following are some of the troubles that may be caused by a deficiency:—

(1) Osteoporosis or osteomalacia, commonly known as cripples in Western Australia (probably identical with the S. African *Styfziekte*, and with a cattle trouble reported from North Taranaki, New Zealand (Jour. Dep. of Agric., N.Z., Nov. 15/12)). A similar disease, known as bush sickness, is reported on New Zealand pumice soils (Jour. Dep. of Agric., N.Z., Aug. 15/12.) Osteoporosis is a direct result of the deficiency, and is found in many

parts of the world, generally on soils deficient in phosphoric acid, or containing an excess of organic matter. It is generally seasonal in its incidence. Law, in "Veterinary Medicine," writing of dairy cattle and English conditions, says "it usually occurs in spring, after seclusion of winter, on exposure to cold winds and strain of parturition and milking." As stated above, in Western Australia it usually occurs at the end of summer. The true cause of this is very often not realised as the symptoms are complicated with indigestion, attributable to the deficiency of the mineral constituents of the food, and the miscellaneous materials ingested as a result of the unnatural appetite; also a post mortem discloses parasites in the fourth stomach, an unhealthy animal being always more susceptible to parasitic infection.

It is probable that the stiffness is caused by auto-intoxication, or a poison produced within the body. The farmer doses with aperients; this assists to remove the poison, and should the cow go dry and so have a smaller drain on the minerals, or be put on better feed, she gradually recovers.

(2) Dry Bible or Paralysis Impaction. This is an indirect result of the deficiency, and is reported from New South Wales, Queensland, South Australia and Victoria, and at least one authentic case from Western Australia (see Victorian Journal of Agric., Vol. XX., No. 9). It is due to a toxin or ptomaine poison, produced by a toxicogenetic saprophyte in bones and other tissues of dead animals. The organism responsible for this is not the Bacillus botulinus, but a somewhat similar one.

The effect of the toxin is to cause paralysis of the gullet and alimentary tract, causing stagnation in the stomach and intestines. This impaction is the result and not the cause of the trouble. Being unable to drink, the moisture is drawn from the food in the stomach, etc., and hence this food appears unduly dry after death.

In South Africa many cattle have been lost from Lamziekte, a complaint caused by a toxin found in bones, and similar in this respect to Paralysis Impaction, but not identical with it.

These diseases (see Jour. of S. African Dep. of Agric., Vol. I., No. 3) are difficult to cure once the toxin has been absorbed, but are easily prevented: (1) By feeding the stock so that they will no longer crave for and chew bones. (2) By burning all dead carcases.

It will be realised that only a slight deficiency may be dangerous should the bacillus producing the toxin be present on the farm.

(3) Where the cattle are short of bone-making material, the bones are sure to be weaker.

In one local case, a cow was seen to collapse when standing quietly by herself in the stockyard, on examination, it was found that the pelvic bones were broken. She was slaughtered, and it was then discovered that the bones were so soft, that they could be perforated with a blunt wire. This is an extreme case, due to a dairy cow drawing on her skeleton to make good a deficiency in the food.

(4) Though not definitely proved, there is a great probability that many cases of barrenness and irregularity in breeding are due to the same cause. "Good authorities consider that whole herds fail to breed during a limited period, apparently because of their state of nutrition, there being no evidence of contagious abortion" (E. B. Forbes, Jour. of Dairy Science, Vol. II., p. 15).

(5) Where cattle chew bones there is always some danger of choking, from getting a bone stuck in the gullet.

Methods of Overcoming the Shortage.

Where a shortage exists, it will be necessary to tackle it in more than one way to get the best results. The various methods may be grouped under the following heads:—

(a) Feeding of phosphates direct in the feed.
(b) Provision of licks.
(c) Top dressing pastures with phosphatic manures.
(d) Growth of legumes in preference to gramineous crops.
(e) Provision of green feed and silage during the dry months.

(a) Feeding of phosphates direct is placed first, because it can be availed of as soon as it is noticed that cattle are chewing bones.

Any of the following may be given at the rate of 2 to 6oz. a day, mixed in the feed. It will probably not be necessary to mix bonedust with feed, as cattle will generally take it as it is:—

(1) Bonedust made from clean, sound bones from healthy stock. This is often difficult to procure of sufficiently good quality, and in this State is always more expensive if purchased than other forms of phosphate.

(2) Ground Rock Phosphate. This is an economical substance to use, and has the desired effect. The writer some years ago wished to make use of a scrub paddock that contained a lot of rough feed, but found that cattle paddocked in it were mad for bones. Bonedust of sufficiently good quality being difficult to purchase and having ground rock phosphate on hand, a trial was made of the efficiency of the latter for the purpose. About 2lbs. of the phosphate were mixed with about 10lbs. of a mixture of equal parts bran and pollard, and fed to 8 head of young cattle, this quantity being given three times a week. The result proved that the ground rock phosphate was effective, as the stock did well, and when they had access to bones no longer attempted to chew them.

(3) A mixture of 4 parts superphosphate to 1 part lime can be relied on to be of benefit, but is a little more trouble and more expensive per unit of P_2O_5. In one case in particular, a herd of 12 head had developed allotrophaga and six of them had developed stiffness, one in particular being so stiff in the limbs, or they were so painful, that she would not feed standing up. On the writer's recommendation, a mixture of 4 parts super. to 1 part lime, at the rate of a dessert-spoonful a meal was given in the feed of chaff. The owner reported after four days that the cattle were improving and after six weeks that the stock had actually improved in condition in spite of the fact that one of his best paddocks had been burnt out. This was evidence that it was not so much the feed as lack of the correct constituents in the feed that was causing the trouble.

Superphosphate alone is of benefit. Mr. Baron-Hay reports that he recommended this mixed in the feed for cattle that appeared to be suffering from a deficiency with distinct benefit. In another case, where cattle got at some bags of super., they were seen to improve in appearance and to put on condition.

(b) Provision of licks.

This is the only method possible where cattle have a big range, and cannot be fed at least twice a week. When necessary to provide a lick, trial should be made to find a lick rich in phosphates that cattle will like and consume readily.

Some of the commercial licks that give a good result in one district do not give good results under different conditions. The herd of twelve head referred to above had had a commercial lick in front of them, but had not taken sufficient of it to keep them right.

A possible reason why stock do not take readily to some licks is because there are patches of salt in the country where they run and, getting sufficient salt in this way, leave the licks alone, particularly if the lick contains a large percentage of common salt.

(c) Top dressing of pastures with phosphatic manures.

Top dressing increases the yield per acre, but the direct benefit is not merely the extra quantity of feed; the quality of the feed is much improved, and it is probable that that extra quality is in great part due to the extra quantity of minerals contained in the fodder. The quality of the herbage in feeding value is even more dependent on the soil than on the kind of plant, the same variety of plant on a rich soil having a higher feeding value than it would have if grown on a poor soil. This applies to the vegetative part of the plant; the seed tends to be similar wherever grown. Phosphatic manures encourage the growth of legumes (see below) directly, extra growth of grasses and miscellaneous plants is chiefly indirect, as the legumes obtain their nitrogen from the air and the residues of the leguminous plants make the soil richer for the plants that have to obtain their nitrogen from the soil.

The stock on top-dressed pasture are healthier, chiefly because their mineral wants are supplied through the plants. Osteoporosis is unlikely to develop while top-dressed pasture is available. To quote E. B. Forbes (Jour. of Dairy Science, Vol. II., p. 17): "Consider with care your meadows and pastures: they are often neglected; if the soil is not rich the mineral nutrients in pasture grass may be doubled by fertilisation."

(d) Growth of Leguminous rather than Gramineous Crops.

As stated above, cattle are unlikely to suffer while feeding on a top-dressed pasture, as our pastures generally contain a large proportion of clovers and trefoils. It is when they dry up and the pastures are very bare and hand feeding is necessary, that the stock owner must endeavour to provide leguminous roughage instead of oaten or wheaten hay.

Ingle, while investigating osteoporosis in mules in South Africa, came to the conclusion that the trouble was to a great extent caused by a too exclusive diet of oaten hay, which contains the minerals in an incorrect proportion. Many stock owners are of opinion that as long as the foodstuff contains a high percentage of ash it will make bone, but this does not always follow. Bran is a food that contains a large amount of ash, yet horses kept on bran to the exclusion of other foods are liable to suffer from Short's disease, or Miller's horse rickets; probably due to a shortage of lime salts or a very low ration of lime to phosphoric acid. An ideal food will contain at least an equal proportion of lime to phosphoric acid. The following table gives the ratio of P_2O_5 to CaO and is from the analyses of Wolff & Warington:—

	P_2O_5.		CaO.
Lucerne Hay	1	:	4.78
Crimson Clover Hay	1	:	4.45
Oats Whole Plant (green) ..	1	:	0.77
Oats Whole Plant (Ripe) ..	1	:	0.62
Oat Grain	1	:	0.16
Bran	1	:	0.09

This shows why cattle receiving lucerne and clover keep in good health, while others apparently equally well fed on bran, oats and oaten chaff may suffer from osteoporosis.

From recent work, it has been found that the animal has greater difficulty in absorbing lime than phosphorus pentoxide from the food. Although, as stated above, these substances are in approximately equal amounts in cows' milk, they are doubtless in a form that is very easily assimilated. In the less easily digested foods it is of advantage to have the lime in excess.

Working on Warington's analyses of English crops, which will not exactly correspond with those locally grown, but will, nevertheless, give the reader a good idea of the quantities required to supply the minimum amount of minerals for a cow yielding 3 gals. of milk, *i.e.*, 2.25 oz., CaO and 1.6 oz. P_2O_5.

	Quantity required to supply—	
	2.25oz. CaO.	1.6oz. P_2O_5.
Red Clover Hay	7lbs.	18lbs.
Oaten Hay	43.7lbs.	23.9lbs.

That is to say, as her capacity for hay fodder is limited to 35-40lbs. a day at most; if fed exclusively on oaten hay, she would with difficulty eat sufficient to supply her lime requirements, and her digestive system would with great difficulty cope with this large amount of roughage. She would also be getting insufficient of the other food nutriments to keep up her supply of milk; an omission of some of the oaten hay and addition of concentrates would assist with these but not with the minerals. With the clover hay, on the other hand, a comparatively small amount will supply the lime requirements. If the cow is milking heavily a good proportion of concentrates, low in minerals, can be fed with leguminous roughage without risk to health, and if the cow is dry, or nearly so, during the scarce season for feed, she can with advantage be fed clover hay as an addition to any feed in the paddock.

In the wet South-West, the most generally practical way of providing leguminous roughage for the scarce season is to top-dress a clover paddock and save it for hay. It can, however, be grazed with little, if any, detriment to the succeeding hay crop until the end of August; the stock should then be kept out and the grass cut for hay when the clover is in flower.

The best conditioned and healthiest stock seen by the writer during the present very dry season have been those receiving clover hay.

There are but few farmers who make a practice of conserving fodder in this State in the form of clover hay, but of those who do one reports a yield of 7½ tons of chaffed hay from 2 acres of mixed Crimson Clover and Cow Grass; another 14 tons from 6 acres of grass consisting chiefly of Clovers—Subterranean, Cluster, Yellow Suckling; and the Departmental Experiment Plot at Balingup, top-dressed with super, gave a computed yield per acre of 27 cwt. In the last case a big percentage of the growth consisted of Yellow Suckling Clover (*T. minus*), which is never a very heavy yielder.

(e) Provision of green feed.

Some investigators are of opinion that green feed assists the utilisation of minerals by the animal, but this is not yet definitely decided. But certainly some green feed is likely to give a healthier and, therefore, more vigorous

digestive system that will be able to make the best possible use of any minerals in the feed. Where the farmer has moist land there will be no great difficulty in securing some green feed; on drier holdings silage will be found useful.

From experiments with dairy cows (Ohio Agric. Exp. Station, Bulletin 363) it was found that good cows, for the first few months after calving, even when fed a diet rich in mineral, lost a certain amount and were evidently drawing on the skeleton, it being apparently easier to draw on these body reserves than to assimilate from the feed the large amount of minerals required.

It was also found that these reserves were built up in the body towards the end of the lactation period and at a particularly rapid rate while dry, just before parturition.

This points to the desirability of a rest between each lactation period, and to the need of a plentiful supply of legumes or of minerals in the feed at the end of the lactation period until in profit again.

In young and growing animals it has been found that absorption of minerals is assisted by plenty of muscular exercise. Under similar conditions in every respect, except that one was confined and the other had freedom and exercise, the animal getting the exercise grew a bigger and stronger frame. The only farm animal to which this is likely to apply in Western Australian conditions is the pig, the young of other farm animals generally having a free range. With pigs, it will be found best to feed well and give plenty of room, preferably in a grazing paddock while growing the frame, confining to a sty when fattening.

The best time to lay up a store of mineral is in the young growing animal. "The primary opportunity for building up the nutrient reserves of the cow is during the growth of the heifer. Dairymen have debated the question as to the wisdom of liberal feeding during this period with the preponderance of sentiment in the affirmation. The facts as to the mineral metabolism of the cow suggest the great desirability of making the most of the storage or constructive possibilities of the animal at this time." (Ohio Agric. Exp. Station, Bull. 363).

Summary.

A shortage of minerals is shown by bone chewing, an unnatural appetite, and in a more acute form by stiffness, usually in the fore limbs. Though an insufficient supply of minerals is bad for any stock, the heavy milking cow was the most likely to suffer, because while milking heavily she loses mineral rapidly, and unless she secures food rich in minerals when dry her bodily reserves are not replenished and she starts the next lactation period with poor reserves to meet the strain. When this shortage is apparent it can be overcome by feeding lime phosphates direct, either bonedust, ground rock phosphate, or a mixture of 4 parts superphosphate to 1 part lime at the rate of 2 to 6 oz. per day.

A preventive is to top-dress the pasture and to feed leguminous roughage grown on soil naturally rich in lime phosphates, or that has been top-dressed with phosphatic manures.

THE "STRENGTH" OF WHEAT AND FLOUR AND ITS DETERMINATION.

R. G. Lapsley, B.Sc. Agr. (W.A.), A.A.C.I., M.R.San. I.

The most generally accepted definition of the term "strength," as applied to flour, is that enunciated by Humphries, who in 1905, before the International Convention of Millers held in Paris, defined it as *"the ability to make large well-piled loaves."* Thus flours which bake out well have been given the arbitrary term of "strong" flours, whilst other flours, which are deficient in this respect, have been termed "weak." Varieties of wheat which produce "weak" flour have grain which is floury or soft, and are usually called "soft" wheats. Similarly, varieties which produce "strong" flour are in Australia known as "strong" wheats. The grain of these latter varieties is usually translucent or horny in appearance, and in character more flintlike or harder than the soft type. For this reason the strong varieties are also termed "hard" wheats. It is by this term that they are generally referred to in Canada and the United States of America.

The characteristic "strength" is of great importance to the baker, for upon it depends the number and quality of the loaves obtainable from any parcel of flour. Because, therefore, of the important place which bread holds in the dietary of man, any facile method for determining the comparative strength of different samples of flour is of great economic importance. Methods for determining "strength" of flour have, therefore, received a great deal of attention from scientific workers during the last 25 years. Without going into the details of the large volume of biochemical research work which has been carried out, it may be stated that it is agreed by almost all authorities that the factors intimately connected with or which control strength are—

(a) The quantity of gluten present in the flour.

(b) The quality of the gluten (*i.e.*, its physical properties).

(c) The diastatic activity of the flour.

Each of these factors is in itself very complex and each may, singly or conjointly, exert a powerful influence on the control of "strength."

According to the latest views of Sharpe and Gortner (1922), we have at least three classes of weak flour, viz.:—

(a) Weakness due to an adequate quantity of gluten, but of inferior quality.

(b) Weakness due to an inadequate quantity of good quality gluten.

(c) Weakness due to factors influencing yeast activity.

Because the gluten of flour is thus shown to be variable in its quality, it has not been found possible, as was once thought, to determine the strength of flour by the result of an estimation of its gluten content.

Unfortunately no method has yet been found which can supersede the actual baking test for absolute accuracy. Such a test has, however, the disadvantages that it is slow and requires, when compared with chemical tests, a comparatively large quantity of flour. The former requirement is a serious handicap for commercial purposes. It is also somewhat of a handicap to the plant breeder, who, unless his work is to be unduly pro-

Fig. 1.—Small Roller Flour Mill in Government Chemical Laboratory.

longed, can only supply the cereal chemist for testing purposes with such small quantities of wheat as are sufficient to meet the requirements of a small experimental roller mill similar to the one illustrated in Fig. 1, and which is installed at the Government Chemical Laboratory for that purpose.

WATER ABSORPTION AS A TEST OF STRENGTH.

It was found by Guthrie, of New South Wales, in his earliest experiments in connection with the examination of flours from wheat milling tests, that the largest and best loaves were always obtainable from those flours which had the power of absorbing the largest amount of water. These observations were confirmed elsewhere. It has, therefore, seemed justifiable in Australia to continue to regard the relative power of absorbing water as an indication of the baking quality of the flour in question. Whilst such may not afford the same accurate comparison as an actual baking test, it is a valuable index of the relative comparative "strength." Such a method has proved reliable enough to furnish information of commercial value to millers, and in consequence of the results obtained by it, selections have been made, as the result of which strong varieties like "Comeback," "Bobs," "Jonathan," "Carrabin," and others, have been produced and brought into general cultivation, so that the need for importing the "strong" or "hard" varieties from Manitoba no longer exists or takes place.

The method introduced by Guthrie is described by him as follows:—

> "The strength is estimated by weighing out 1½ oz. of flour and making it into a dough with water run in from a graduated burette. The water is run in until the dough is of such consistency that the lump when firmly squeezed in the hand can no longer be detached: at the same time, the lightly-rolled dough can be pulled apart into a long fine thread. This test depends, of course, upon the judgment of the operator, and two experimenters would probably obtain somewhat different results, but a little practice enables one to hit upon the proper consistency with considerable accuracy, and for purposes of comparison the numbers are reliable.
>
> The burette is so graduated that a simple calculation gives the amount of water in terms of the number of quarts of water to the sack of 200 lbs."

As already stated, this method has done yeoman service in Australia, and, whilst the comparisons desired can be made by one operator, it is fairly satisfactory, but, unfortunately, no two analysts operate alike.

With the increased interest which has been aroused in the testing of flour in the wheat-producing States, largely as the result of the activity in connection with production of new and better varieties throughout the Commonwealth, it has become extremely desirable since the method referred to was devised to have a method by which comparisons can be made between the tests carried out by operators in the different wheat-producing States. The need for making such comparisons has brought into prominence the defect referred to by Guthrie when he first described his method, viz.: "This test depends, of course, upon the judgment of the operator, and two experimenters would probably obtain somewhat different results."

Modifications in the methods connected wtih the manipulation of the original test by Guthrie have, from time to time, been introduced by workers in this State to improve that method, and specially to overcome the deficiency referred to. One of the first successful modifications of the method

was the use of a mechanical dough mixer of standard pattern. This dough-mixer had been used satisfactorily in the Victorian Department of Agriculture's laboratory, and, through the courtesy of Mr. P. Rankine Scott, the Agricultural Chemist, it was introduced into this laboratory with equally satisfactory results.

It has been found that the mechanical mixing with the dough-mixer has eliminated many of the differences due to the personality of the analyst, as the speed and amount of mixing is under definite control and can be standardised.

During the operation of the dough-mixer it has been noticed that decided changes gradually take place in the consistency and physical pro-

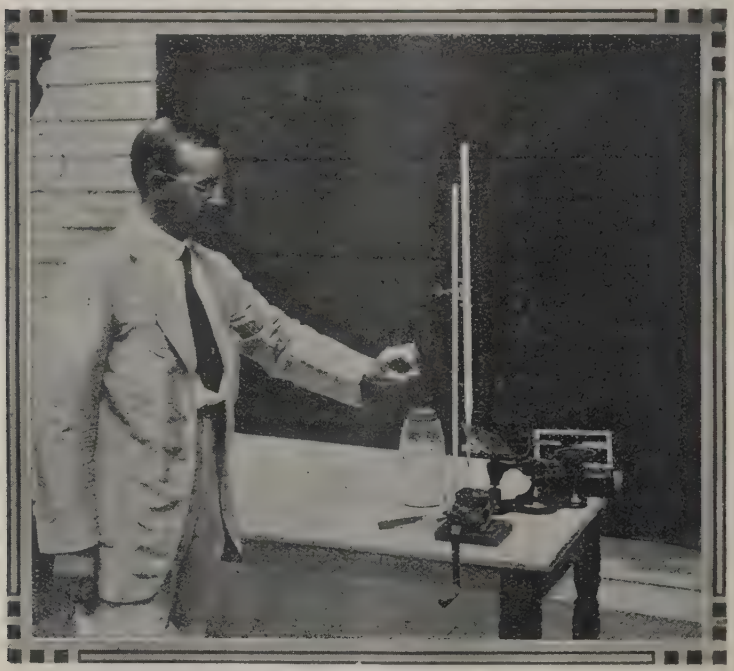


Fig. 2.—Determining the "end point." Commencement.

perties of the dough as additional amounts of water are added when working towards an arbitrary "end point." These gradual changes are not identical for strong and weak flours, but are more pronounced with the softer or weaker flours. Because of these physical changes, the method described by Guthrie of determining the "end point" has not been found satisfactory. It was therefore necessary to devise a new method. This has been done, and the elasticity and tenacity of the dough have been used in order to get a sharp "end point," and one which does not depend to any-

thing like the same extent upon the individuality of the operator. For this reason alone it is believed to be a distinct advance upon the old method. This "end point" gives close agreement to the baker's results.

METHOD OF DETERMINING THE "END POINT."

The method of determining the "end point" is: Take from the batch a small ball of dough about ⅜in. in diameter and squeeze this between the left hand index finger and thumb (both previously cleaned and dried). This phase is illustrated in Fig. II. The finger and thumb are then gradually drawn apart until they are separated by a distance of six inches.

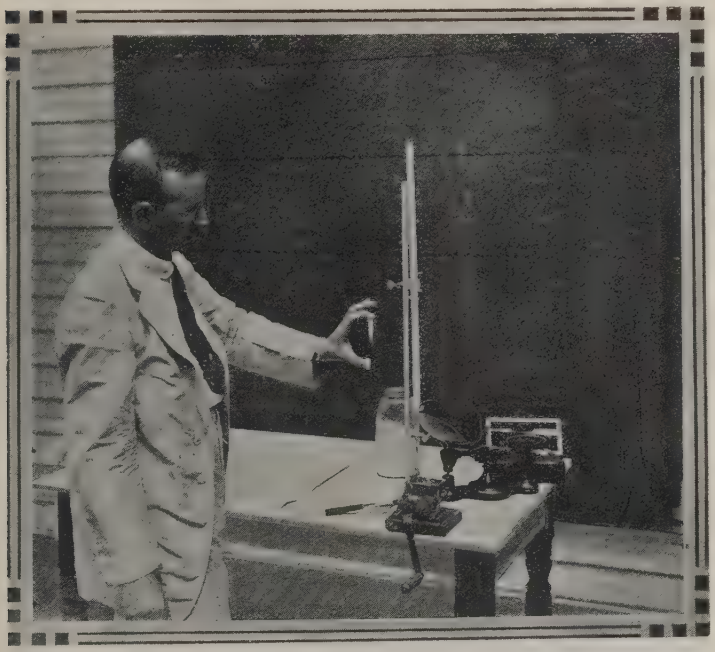


Fig. 3.—Determining the "end point." More water required.

Should the string of dough break before this distance is reached, as is the case in Fig. III., it shows that insufficient water has been added, and the trial piece of dough is returned to the batch and more water added until it is found by further trial that the dough will stretch out in a string between the finger and thumb, as shown in Fig. IV., for the full six inches.

For the complete test for "strength," as now carried out in Western Australia, two trials—a preliminary and final one—are invariably required to test each sample of flour. To make the preliminary trial the dough-mixer,

as seen on the front of the table in the illustrations (Figs. II., III., and IV.), is set up and securely clamped down. The burette is set up over it and filled to the zero mark with distilled water. Forty grams of flour are then weighed out and placed in the mixer. Twenty cubic centimetres of distilled water are next run into the mixer on to the flour. The dough-mixer is then given 100 revolutions, which occupies about one minute. The sides of the mixer bowl are cleaned down by means of a spatula with a square end, and the material thus removed is mixed in with the other dough. Further turns are then given until 120 is recorded, after which .5 cubic centimetres of distilled water is added from the burette and 20 more turns given to the machine. This addition of ·5 c.c. water, together with the 20 revolutions of the mixer, is repeated until the dough assumes a creamy appearance. The dough is then ready to be tested for the "end point."

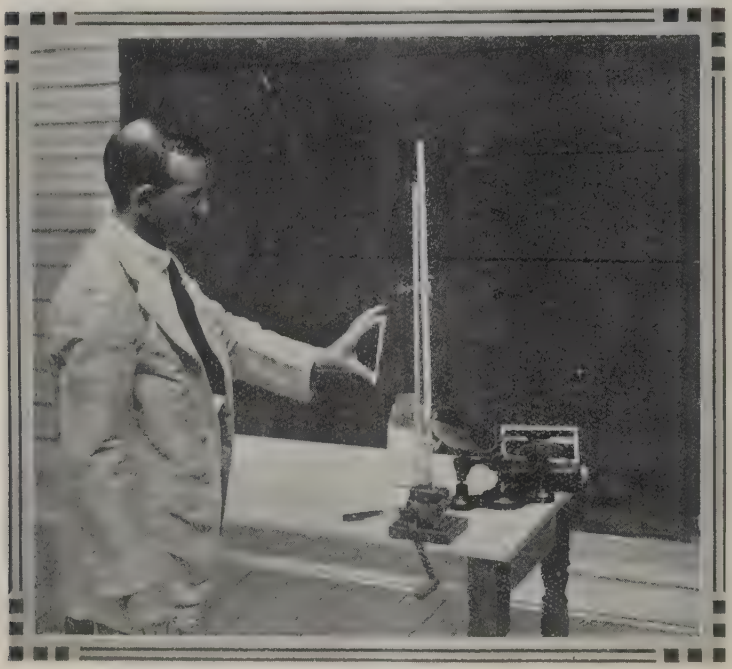


Fig. 4.—Determining the "end point." The "end point" reached.

If it is found on trial that the trial dough will not stretch the required distance, as in Fig. III., it is returned to the mixer and ·2 c.cs. of water added, the mixer revolved 20 times, and a further trial made. This procedure of adding ·2 c.cs. of water and revolving the mixer 20 times is repeated until the desired stretch is obtained and the "end point" found to have been reached. The amount of water used in connection with this preliminary trial is noted for use in connection with the second test.

For this test the procedure is the same, except that the whole of the water used in the preliminary test is now added and the dough-mixer revolved 200 times for the samples of flour which absorb less than 35 c.cs. for 40 grammes of flour, and 300 revolutions for those which absorb more than this amount. If the characteristic creamy appearance is not reached when the specified revolutions have been given, ·1 c.cs. water are added and the mixer given 20 revolutions, this procedure of adding ·1 c.cs. of water and giving the dough mixer 20 revolutions is repeated until the dough becomes creamy and until the "end point" is again reached. This second end point is the one adopted. A simple calculation gives the amount of water absorbed in terms of the number of quarts of water to the sack of 200lbs. This figure indicates the comparative water absorbing capacity, or, as understood in this State, the "strength" of the flour sample.

ERRATA.

An error occurred on page 65 of the April issue of this *Journal* which may lead to a wrong conclusion. In the article dealing with "Experiments with Wheat," the rates of seeding trials carried out by farmers are detailed, and the result of that carried out at Kellerberrin by Mr. J. D. Hammond with Gluyas Early is stated to be an average of 11 bushels 28 lbs per acre. It is obviously an error. The correct figures are *21* bushels *13* lbs.

The concluding portion of the same article was accidentally transposed from page 69 to page 55 during the process of making up the *Journal*. The mishap was not discovered until too late to rectify it, but a small printed slip was inserted in each *Journal* on page 69 indicating where the final paragraph would be found.

THE BRITISH EMPIRE EXHIBITION.

WESTERN AUSTRALIA'S EXHIBITS.

By the EDITOR.

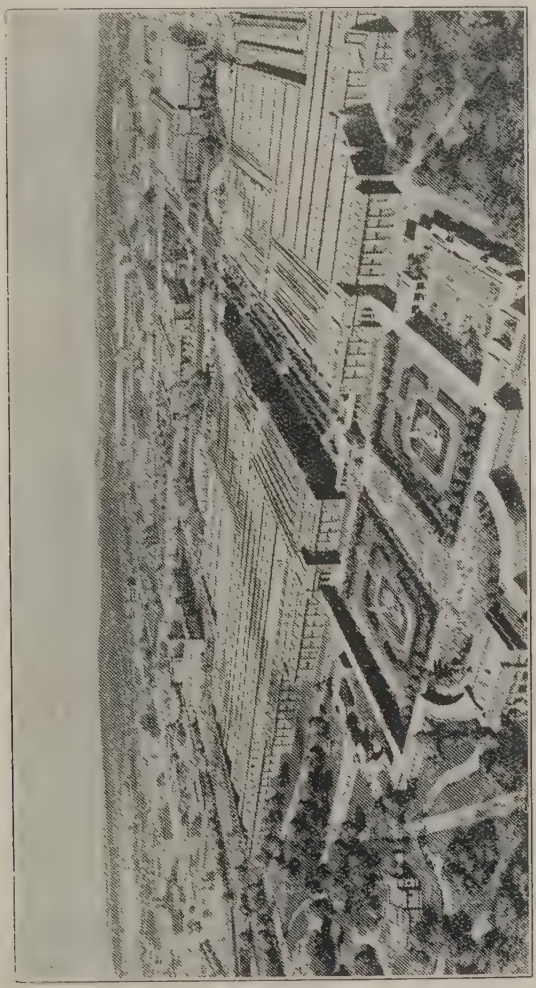
The eyes of the world, and especially of Britain's Dominions, are turned towards the Mother Country at the present time by reason of the great Exhibition which was opened at Wembley Park in April. It is a miniature city of magnificent buildings, in which is displayed the full story of the Empire's wealth of produce, inventions, and manufactures, and it will afford opportunities of increasing these resources and stimulating inter-Imperial trade.

The originators of the scheme described the Exhibition as "an Imperial stock-taking and a vast window display which will dispel any doubts as to the Empire's unlimited potentialities, and will undoubtedly have the effect of inducing British manufacturers to look to the Dominions for their raw materials in preference to purchasing from foreign nations."

Australia is the largest producer of wool in the world. It has also great possibilities as a cotton growing country, as the Queensland exhibit attests, and the quality of the small West Australian exhibit may prove an inducement to British capitalists to investigate and assist in developing the industry in the North-West. The successful establishment of the cotton industry in that portion of the State would mean the solution of a great many problems regarding its vast and scantily populated area. Raw materials of many other kinds are also being exhibited, most of which require only capital to ensure their complete development—the quality and quantity are assured. Their manufacture in Australia into marketable goods must then surely follow. There are three prominent features of the Exhibition: It will be a highly interesting display for the merely curious; it is a great demonstration to the peoples of the British Empire of the Empire's possibilities of production; and it is a stimulus to Imperial patriotism.

Western Australia's collection of exhibits is a worthy representation of this State's wealth, and affords a striking picture of the opportunities awaiting migrants who are willing to work. The Wheat Belt has provided high grade wheats, in the ear and in bulk, which cannot fail to impress the British flour millers. The mineral resources of the State have yielded a wide variety of samples—gold, coal, silver, tin, copper, and other metals—and striking statistics accompany them to indicate the generous supplies awaiting exploitation. Our timbers are already well known, but the exquisite creations which have been evolved from jarrah and other native hardwoods by skilled craftsmen will astonish many who know the timbers only as useful adjuncts in big building and engineering schemes. In addition to manufactured articles the Forestry exhibit also includes a collection of oils, essences, etc., that are of considerable economic value, the production of which in sufficient quantity would mean the establishment of other industries. The Educational exhibit is a display of manual work done in our

primary and rural schools, and includes some clever examples of wood and metal working, both ornamental and practical, as well as a fine display by the household management section. The whole of this exhibit is the work of pupils under the age of 15 years. A not unimportant portion of the



Bird's-eye View of the Grounds, Wembley Park.

State's contribution to the Australian section are the literary and pictorial representations of the activities and industries and general conditions existing here, which will go far to give a true impress of our life conditions. Profusely illustrated pamphlets, attractively written by experts and artisti-

cally printed, are being sent forward weekly for free distribution to visitors to the Australian pavilion, and, together with the exhibits of products, will convincingly demonstrate to those who read as they run that there are still almost unlimited quantities of those products available. Photographs enlarged and coloured, to the number of about 400, showing life-like presentments of all our industries, of our cities and towns, and of our manufacturing processes will also give a truer perspective of Western Australia than could be gained from columns of printed matter; and in some instances comparative pictures show the progress the State has made over a period of years. Opportunity has also been taken to combine two exhibits by using for picture frames a large number of our native timbers. The picture shows the forest in its natural state, and the frame shows the artistic uses to which the timber, when cut, can be put.

The agricultural possibilities of the State, as befits a country of such prodigious potentalities in agricultural and pastoral production, are embraced in an exhibit that is at once elaborate and convincing. Samples of fleece and bale wool, comparable with the best of the world's supplies, have been collected from the leading pastoralists of the State, and have been put up attractively, together with statistical graphs indicating the growth and production of the wool industry; prime flour, made from the wheat for which Western Australia is rapidly becoming noted, has been supplied in quantity by the most prominent flour millers; farming implements, specially constructed to suit Western Australian conditions, and manufactured at the State Implement Works, will occupy an important position in the exhibit of Australian farming machinery, and about 80 bags of locally grown wheat, barley, rye, and oats will afford means of comparison with those of the other States. The wine industry is represented by samples of the different wines produced in the State and supplied from the three principal wine cellars; and the refrigerated products included 150 carcases of frozen lamb, a variety of tinned meats and other products from the Wyndham Meat Works, and 10 cases of potatoes. The fruit growing industry is particularly well represented. The Fruitgrowers' Association rendered enthusiastic assistance in collecting an exhibit that would do credit to the State, and in addition to a choice collection of the best export varieties of apples grown in the Bridgetown and Mt. Barker districts, which went forward in time for the opening of the Exhibition, a monthly supply was forwarded by the Association during March, April, and May to renew the Exhibit from time to time at the Exhibition. Oranges and grapes are also included in this exhibit. Apiculture is represented by a case of honey containing samples from six different portions of the State, which, while small in quantity, will serve to show that a good quality article can be produced, and that bee farming is a valuable sideline in suitable districts. Statistical data, graphically presenting the progress the various agricultural activities in the State have made during the past 25 years, are also shown. They are artistically printed or drawn, measuring six feet by three feet and framed in polished jarrah, and are a first-rate means of conveying at a glance general and concise information concerning the whole of the agricultural industry.

The wheat trophy which has been forwarded from this State is, however, the *pièce de resistance* of the Australian wheat exhibit. It was designed and prepared, at the request of the Federal Empire Exhibition Commission and under the control of the Agricultural Group Committee, by the officers of the State Agricultural Department, in conjunction with the State Imple-

ment Works, and is intended to typify the wheat-growing industry in all the Australian States. Life has been given to the model by an ingenious arrangement showing wheat flowing from Australia all over the British Isles from four sides of the model. It is in the form of a pyramid, having a base 16 feet square and a height of 20 feet. Projecting from the base is a counter or platform three feet wide on which are exhibited samples of Australian Strong White Wheat and Australian Premier Strong White Wheat. The counter is framed in with samples of flour made from these Australian wheats. At each corner of the base is a square pilaster of glass on which transparencies depict in turn each of the four main factors responsible for the development of wheat-growing in Australia, viz., transportation, machinery, superphosphates, and wheat breeding. The central portion of the trophy, which is over nine feet square, springs pyramid like from the base. At the foot of this central portion, in polished jarrah panels, are fitted sets of coloured photographs illustrating the progress of development of an Australian wheat farm, beginning with the clearing of the land, showing the process of burning off, the pioneering methods of preparing the soil, the resultant crop, the harvesting of the golden grain, and the carting of it to the railway depôt. Superimposed on these photographs are niches containing small sheaves of 44 different varieties of wheat, and these represent almost all the varieties which are responsible for the Commonwealth wheat production. Throughout these representative varieties of wheat are interspersed coloured photographs which show in an impressive fashion the large teams that are a characteristic feature of profitable wheat farming in Australia. One of these photographs shows a set of harrows drawn by 11 horses and driven by one man, by which 100 acres per day was cultivated. Other photographs depict further arresting achievements that are accomplished by big teams and big machinery. Towering over the whole of the base is a huge pyramid of wheat in sacks. These are capped by transparent maps of Australia, from which the spectators may see a stream of wheat grains flowing from Australia to Great Britain, which is shown on another map lower down, thus indicating allegorically the part Australia is playing in providing food for the Motherland.

The arrangements for the complete West Australian exhibit were distributed amongst various group committees, and their efforts were co-ordinated by a State Executive, which in turn was dominated by the Federal Commission, the finalising body for the whole of the States. The various industries or activities of this State were grouped into the following divisions: Agriculture (comprising agriculture, horticulture, viticulture, pastoral, and dairying); Minerals; Forestry and Forest Products; Fisheries and Native Game (including marine products and zoology); Education, Manufactures, and Publicity, and for fully 12 months the individual committees representing these groups laboured unceasingly collecting and classifying exhibits from all parts of the State so that a truly representative exhibit, representing the best the State can produce and which will do justice to the vast resources within its territory, should be placed before the people of Great Britain and other nations of the world who will be visiting England for the purpose of inspecting the great exposition at Wembley Park. The foregoing, which is but a brief resumé of the details of that exhibit, is evidence that their labours were not fruitless, and it is only reasonable to assume that the results will be beneficial to the State, both directly and indirectly, in the very near future.

THE DEVELOPMENT OF A DAIRY HERD.

(*Continued.*)

P. G. HAMPSHIRE,
Dairy Expert.

BREEDING.

Following on the selection of heifers and cows which form the nucleus of the future herd, there should be made a decision of breeding up or "grading up." This must be done by means of the bull. The most important decision is the type and breed of bull, because the sire will be the means of improving the future members of the herd.

"GRADING UP."

Scrub Cow No. 56. Average production 3874.6 lbs. of milk and 192.62 lbs. of fat.

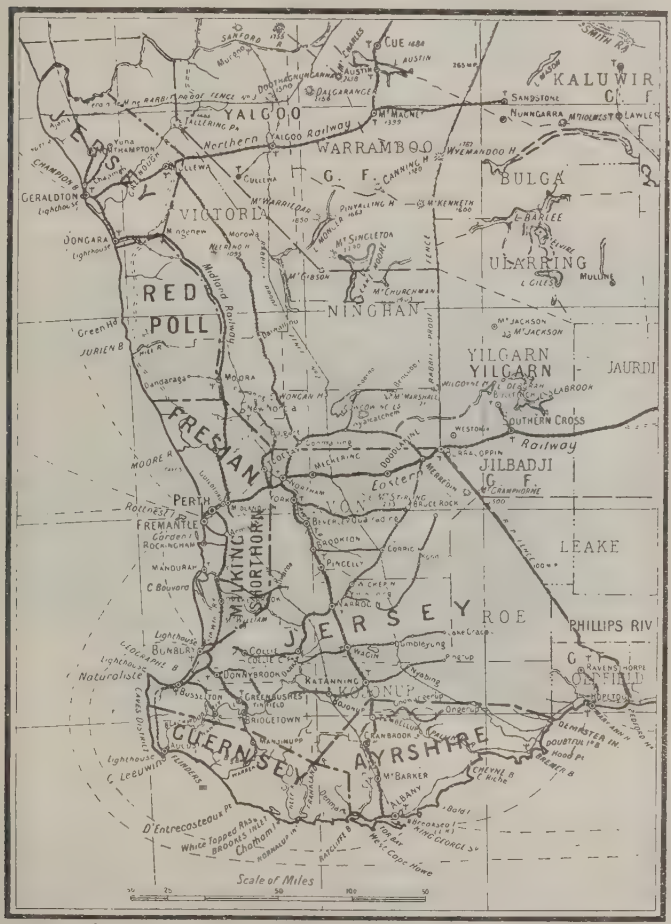
Half-blood Holstein No. 77, out of Scrub No. 56. Average production 6955.5 lbs. of milk and 266.25 lbs. of fat.

Three-quarter-blood Holstein No. 233, out of half-blood Holstein No. 77. Average production 12804.2 lbs. of milk and 482.54 lbs. of fat.

A remarkable example of great improvement in type and production. Note markings and ill-shaped udder "bred out."

This Department has initiated a scheme for the improvement of dairy cattle in Western Australia by dividing the dairying portions of the State

into zones for each of the six dairy breeds, and, after many conferences with the breeders and Royal Agricultural Society, the boundaries were defined and unanimously agreed upon. All dairy sires that are financed by the Government will be registered pure, ex-tested dams with official butter



South-West Division of Western Australia showing Dairy Breed Zones.

fat production above standard, and of the breed allocated to the zone in which the dairy farmer resides. As the majority of the dairying land is new country being settled and financed by the Government, either through the Agricultural Bank or Group Settlement Branch, the ultimate success of the scheme is assured, but it is sincerely hoped that individual farmers, who

do not require Government assistance, will fall in with the scheme and procure a bull of the breed according to the zone in which their farms are situated, as by so doing the success of such definite policy of dairy cattle improvement is complete. The advantages of the zone scheme of breeding and improving dairy cattle are: The suitability of the breed climatically; from a pasturage point of view; the marketing of the production, whether milk or fat; the marketing of vealers, according to the closeness of the market and suitability of the grade steer; and the great advantage of permitting an economical exchange of bulls when a change of sire is necessary owing to numbers of his progeny reaching mating age. It means all your neighbours have Ayrshire bulls if you are in the Ayrshire zone, and so close at hand that an exchange can be arranged; no forced sale of the old bull (at a sacrifice often); no fresh outlay for a new bull; no high freight charge, but just: "You take my bull; I take yours," and, best of all, if we

SCRUB BULL.

"Calamity of Dareein."
The undesirable—the begetter of unprofitable, poor type, low-producing cows.

find the old bull has been breeding wonderfully good producing daughters we know where he is and can get him back and breed more high producers. Again, the first cost of a good bull is distributed over six to eight years and systematic "grading up" is being carried out. From the local Agricultural Show point of view there is an improvement -districts become noted for their cattle, Jersey, Guernsey, etc., as the case may be. Every farmer has one breed in a zone; greater interest will be shown in cattle exhibits; complete and full number of classes, and pens of heifers, cows (milking and dry), groups, etc., with big entries in each, instead of a few animals of each breed with no competition and no interest.

With the use of bulls of various breeds on each succession of heifers there is a conflict of type, and "production" is lost in the fight. Let us look

into the successful breeding of other stock. First take the sheep-breeder. How he would scorn the thought of using a change of breed of ram with each generation as, say, Merino, then Romney Marsh, followed by Lincoln and Border Leicester! The sheep-breeder realises what a hopeless condition his flock would be in if his 15 years' of breeding were on these lines. Rather does he not only keep steadfastly to one breed of male sheep with each mating, but goes further, and uses rams of one outstanding line of blood of the breed, never risking a change of this policy, and to-day Australia leads the world in Merino sheep. The poultry-breeder does not cross Leghorns with Orpingtons and then use a Cochin China rooster on their progeny. The dog fancier does not mix the breeds, and the horse-breeder does not use a different breed of stallion with each mating.

PURE BRED BULL (Milking Shorthorn).

"Emblem of Darbalara." Reg. No. 100.
The desirable—the sire of profitable, good type, high-producing cows. Grandsire of the world's highest production cow, "Melba XV. of Darbalara."

How often a dairy farmer, however, after years of breeding has a nondescript low-producing herd, due generally to the use of low type, ill-bred bulls, or even when the farmer is seized with the value of the pure sire, he changes the breed with each generation. How often do we find, even when a dairy farmer is sufficiently progressive to know the advantage of a pure bull, he undoes the good work started by changing the breed of sire with each bull procured, starting, say, with a Jersey bull. On his daughters he puts an Ayrshire (perhaps because someone said this breed would make them hardier), and then on to the Ayrshire heifers a Shorthorn bull is used (with the idea of size or saleable steers), and with the next change a Friesian bull is used (with the hope of increasing the milk flow), and so on; and, after 10 or 15 years of breeding he has made no advance; his type of stock is nondescript: the production is low, lost through *conflict* of *type* with each mating. If the dairy farmer had set out using one

breed of bull, *never varying* with each generation of breeding, his cows would be highly graded—Ayrshire, Jersey, Shorthorn, as the case may be—one type: three-quarter, seven-eighths, or fifteen-sixteenths pure blood; and, if each pure bull used was the son of a good producing mother, these producing traits or characteristics would be transmitted to the progeny, and the average yield of daughters, grand-daughters, and great-grand-daughters increased, taking averages as a basis. The success of the majority of the dairy stud masters is, as a rule, due to a steadfastness of purpose in breeding, a concentration on one breed, and in all notable instances of high production, such as, for instance, the Milking Shorthorns of "Darbalara," the "Oakbank" Ayrshires, the "Wollongbar" Guernseys, and the "Glen Iris" and "Banyule" Jerseys, a high infusion of outstanding blood of the breed is maintained.

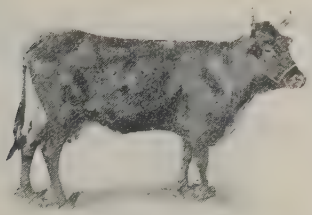
The average dairy farmer cannot buy pure-bred stock, but he can improve his common stock by "grading up"—just as the stud master improves his pedigreed stock by judicious "line breeding."

Systematic "grading up" is the one great means of improving the future herd in type and production. The advantage is: greatly increased interest in the avocation and increased average cow production, pleasure and profit—pleasure in building up a herd to one type, colour, size, and attractiveness; and profit through the increased number of pounds of milk and fat per head per annum. Dairy farmers generally do not value or appreciate the importance of the sire sufficiently in herd improvement, and in herd improvement increased average production is the supreme test. A farmer working on "grading up" lines can look with pride and pleasure to his 10 or 15 years' herd-building, and point to his herd with the knowledge of something achieved, and he can show an increased banking account. Such a policy is not theoretical or an idle dream, it is founded on sound practice the world over. Remember, too, it is much easier to improve the progeny of low producers by the use of high production bred bulls than to increase the production of the progeny of high producing cows—the ratio of increase is reduced as the production of the mothers is increased, and, to improve on such mothers, sires of extra high production dams must be used. We, however, in Western Australia have low average production cows to start with. By using pure-bred tested bulls it is easy to breed better daughters. The Pure Breeds Herd-Testing Scheme is providing the knowledge of where to obtain these pure, bred-for-production bulls—the means of herd improvement; and the Government is willing to assist anyone to procure these "money-making" bulls by loans from the Agricultural Bank, and, even in cases where securities do not permit a further extension of a loan from this Bank, a special fund has been allocated for the supply of these bulls on three years' terms of repayment. No Government could do more to help to increase average cow production, and so make dairying one of the most profitable forms of agriculture.

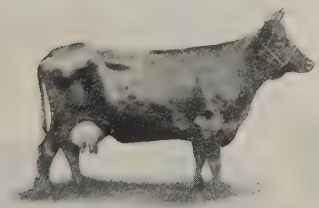
"Breed, Feed, and Weed" are the three axioms to remember. "Breeding" is of foremost importance, because feeding will not greatly improve the production of cows whose female ancestry are low producers. "Feeding" will be necessary to get the best results in all cases, but that true saying, "You can't make a silk purse from a sow's ear" applies very strongly with cows, and, even when everything is done to get the best by

"breeding" and "feeding," still "weeding" or "culling" will be necessary; there will always be some inferior ones, some throw-backs to low producing ancestry, and some of weak constitution, to cull out.

"GRADING UP."



Scrub Cow No. 33. Average production 4338.5 lbs. of milk and 183.49 lbs. of fat.



Half-blood Guernsey No. 87 out of Scrub No. 33. Average production 4213.1 lbs. of milk and 179.72 lbs. of fat.

Three-quarter-blood Guernsey No. 236 out of half-blood Guernsey No. 87. Average production 6582.6 lbs. of milk and 331.11 lbs. of fat.

Improvement in type and marked increase in production with second generation.

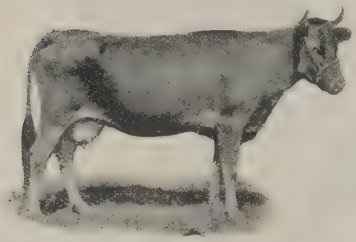
Illustrations are given to bring out graphically what the bull will do in improvement of type and production. There is no getting away from the pure bred "tested bull" to improve our future cows and our banking accounts. Why is it that the pure bull is so prepotent? Why are his progeny stamped with his type and breed markings, and why is it that production is increased if the sire's female ancestry are proved high producers? Purity means prepotency—the bull has been bred pure for hundreds of years—his blood is suffused with one fixed type, virile and strong; when mated with low bred or mongrel cows, his virile blood is uppermost; it dominates; it displaces the mongrel; he stamps his progeny after his own type, and with a long line of high producing cows at the back of him in his breeding,

he imparts to his daughters a high tendency to produce. I do not say that this is always true, but we must be convinced by averages, and averages prove this to be true.

"GRADING UP."

Scrub Cow No. 60. Average production 3313.2 lbs. of milk and 178.47 lbs. of fat.

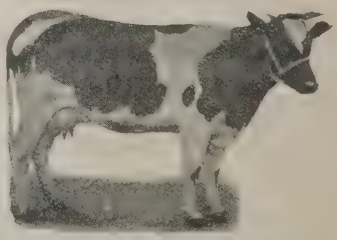
Scrub Cow No. 60. Average production 3313.2 lbs. of milk and 178.47 lbs. of fat.



Half-blood Jersey No. 241, out of Scrub No. 60. Average production 6126.4 lbs. of milk and 348.98 lbs. of fat.

Half-blood Holstein No. 207, out of Scrub No. 60. Average production 6384.9 lbs. of milk and 304.62 lbs. of fat.

Three-quarter-blood Jersey No. 348, out of half-blood Jersey No. 241. Production not yet available.



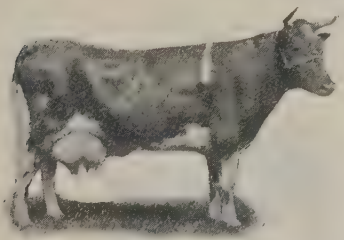
Three-quarter-blood Holstein No. 311, out of half-blood Holstein No. 207. Production not yet available.

Graphic illustrations of the prepotency of the Pure tested Sire, showing daughters and grand-daughters of the same common stock throwing to the Bull, indicating the dominance of the Pure Sire.

Two sets of illustrations show clearly the contention that type follows the pure sire.

In each case the progeny are distinctly of the sire's type, quite unlike the half-sisters. Pure blood dominates, as other illustrations will show. Not every daughter is an improvement on the mother, but the majority are, and the averages are distinctly in the daughter's and grand-daughter's favour, as will be seen.

"GRADING UP."



Scrub Cow No. 53. Average production 5258.9 lbs. of milk and 233.63 lbs. of fat.

Scrub Cow No. 53. Average production 5258.9 lbs. of milk and 233.63 lbs. of fat.

Half-blood Jersey Cow No. 213, out of Scrub No. 53. Average production 4680.2 lbs. of milk and 248.72 lbs. of fat.

Half-blood Guernsey No. 180, out of Scrub No. 53. Average production 3639.0 lbs. of milk and 180.53 lbs. of fat.

Three-quarter-blood Jersey No. 398, out of half-blood Jersey No. 213.

Half-blood Guernsey No. 253, out of Scrub No. 53. Average production 6555.0 lbs. of milk and 321.09 lbs. of fat.

Further striking instances of the dominance of the Pure Bred Sire. Type follows the Pure Bull. Each individual daughter may not show increased production but averages do.

Does the average dairy farmer stop to think what it would mean if he could increase the production of his future herd of 30 or 40 cows by 50 or 100 lbs. of fat per head per annum on practically the same feeding; it is approximately all increased profit. Forty cows with an average increase of 50 lbs. fat means 1,000 lbs. fat at 1s. 6d. per lb. = £150. If, through the use of a pure highly bred bull, this can be further increased to 100 lbs. fat per cow, it is worth £300 per annum increased profit. Innumerable instances can be quoted to show the influence of the sire in increased herd production.

"GRADING UP."

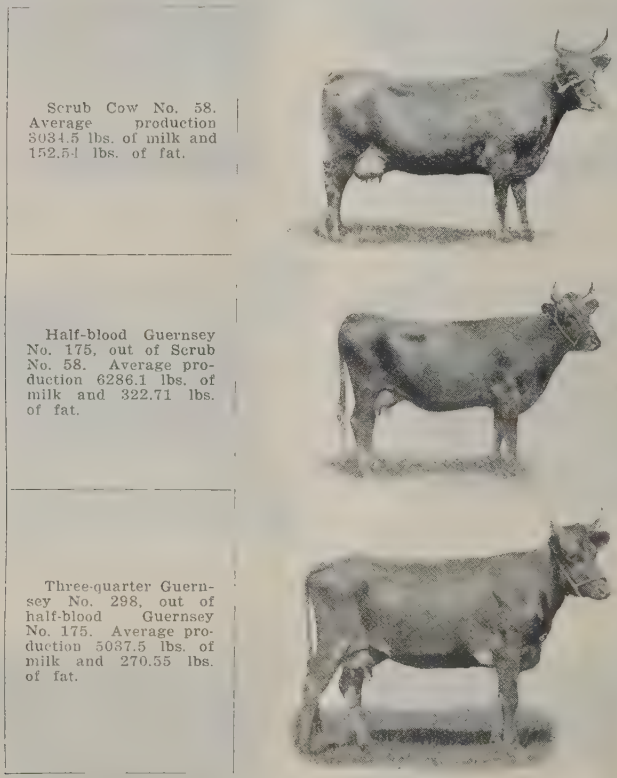

Scrub Cow No. 58. Average production 5034.5 lbs. of milk and 152.54 lbs. of fat.
Half-blood Guernsey No. 175, out of Scrub No. 58. Average production 6286.1 lbs. of milk and 322.71 lbs. of fat.
Three-quarter Guernsey No. 298, out of half-blood Guernsey No. 175. Average production 5037.5 lbs. of milk and 270.55 lbs. of fat.

Figure out what such increased average production would mean in your herd. Any dairy farmer can improve his future returns on similar lines by using Pure Tested Bulls and "grading up."

All results of herd-testing show that where pure tested sires are used herd averages are highest. All dairy sires should be pure and their mothers should be high producers—the higher the production the greater the value of the young bull. The final proof will be the production by his daughters.

Never buy a grade bull out of a high producing impure cow—*he will not breed true.* Never buy a pure bull out of a low producing cow—you want increased production most of all.

A number of matters in connection with breeding will be dealt with in the articles on Management and Culling.

SUMMARY.

1. Select as a sire to mate with the cows available a bull of the breed most suitable for the climatic and marketing conditions, and especially is it urged that the breed be that of the *Zone.*

2. Use only a pure bred bull registered in a Herd Book—the guarantee of purity.

3. See that the bull's female ancestors, especially those *close up,* are proved producers, viz., officially tested.

4. Persevere with the one breed of bull with each successive mating, and thereby "grade up."

5. Remedy evidences of weakness in constitution by the selection of a sire of the same breed, strong in the weak points. Do not be led away to change the breed.

6. Remedy ill-shaped or badly balanced udders, short teats, by the selection of a sire to mate with such cows whose dam and sire's dam are strong in such weakness.

7. A bull's first value is his purity and dam's official production, and the real value is his progeny.

8. Aim at type, constitution, and increased average production.

(To be continued.)

HERD TESTING.

WESTERN AUSTRALIAN OFFICIAL RESULTS SINCE 1st JULY, 1923.

Conducted by Officers of Dairy Branch.

Name of Cow.	Owner.	Breed.	Herd Book No.	Age.	Date of Calving.	No. of Days in Test.	Weight of Milk for Period.	Average Test.	Total Butter Fat.	Weight of Milk Last day of Test.	Remarks.
				Yrs. Mths.			lbs.	%	lbs.	lbs.	
MATURE COWS—STANDARD REQUIRED 350 LBS. OF BUTTER FAT—273 DAYS.											
Carnation of Dardanup ...	R. H. Rose ...	Jersey ...	9995	5 11	9-8-23	273	10,788	5·57	600·99	29	
Brightlass of Wollingury ...	D. J. Goyder ...	do. ...	6818	5 9	31-1-23	273	11,289	4·93	556·74	28	
Daisy 6th of Melrose	W. Padbury ...	do. ...	4512	11 7	16-5-23	273	10,605	5·18	550·05	33	
Maranora of Telleraga	R. H. Rose ...	do. ...	6707	6 2	23-5-23	273	10,533	5·05	531·90	27	
Fondant 3rd of Garden Hill ...	W. Padbury ...	do. ...	7224	11 1	19-10-22	273	9,037	5·52	499·64	27½	
Yarraview Bonnie Annie ...	A. W. Padbury ...	Guernsey...	564	5 10	7-6-23	273	8,127	6·11	496·63	22	
Lily II. of Dardanup	R. H. Rose ...	Jersey ...	8946	5 10	27-8-23	273	9,345	5·24	489·90	25½	
Jessie of Dardanup	do.	do. ...	8945	5 10	31-7-23	273	9,320	5·14	479·25	19	
Retford Buttercup II.	D. J. Goyder ...	do. ...	6830	6 5	18-7-23	273	6,535	6·87	449·52	15	
Morden Lady V. of Waterville ...	A. W. Padbury ...	Guernsey...	130	10 5	24-3-23	273	10,290	4·24	437·21	34	
Daisy of Grass Vale	R. H. Rose ...	Jersey ...	8473	6 11	3-8-23	273	7,615	5·56	423·83	17	
Fancy of Ventonia	T. L. Rose ...	do. ...	8648	7 11	7-4-23	273	7,782	5·35	416·78	18	
Mokine Dianthus	Walker & Co. ...	do. ...	8488	6 2	4-8-23	273	7,153	5·78	410·34	20	
Beauty 3rds Wangara of Pine Hill	R. H. Rose ...	do. ...	6134	6 10	14-8-23	273	9,214	4·44	409·34	26	
Veronica of Tarnpirr	D. J. Goyder ...	do. ...	5174	7 8	27-5-23	273	8,121	4·87	395·70	9	
Madge of Dalebank	D. Malcolm ...	do. ...	4759	10 3	4-8-23	273	6,985	5·59	390·44	17	
Lily II. of Dardanup	R. H. Rose ...	do. ...	8946	5 0	10-10-22	273	7,933	4·92	390·16	18½	
Fancy of Liryclea	A. H. Henning ...	do. ...	6674	5 10	1-8-23	273	7,582	5·10	387·19	21	
Romany Maid of Tarnpirr ...	P. Rose	do. ...	6036	6 2	5-8-23	273	6,823	5·66	386·24	14	
Silver Bell of Roelands ...	A. H. Henning ...	do. ...	10047	5 6	24-8-23	273	7,911	4·82	386·01	20	
Obligato	D. J. Goyder ...	do. ...	4964	8 2	21-7-23	273	7,641	4·99	381·58	16	
Retford Violet	W. Padbury ...	do. ...	6938	5 5	9-3-23	273	6,528	5·78	378·08	15	
Rhodesia of Ventonia	T. L. Rose ...	do. ...	8469	5 0	26-8-23	273	6,884	5·33	366·86	14½	
Overton Mary	W. G. Burgess ...	Ayrshire ...	2601	12 11	10-2-23	273	7,994	4·38	350·51	15½	
Rhodesia 5th of Penryn ...	T. L. Rose ...	Jersey ...	8470	6 11	18-7-23	273	7,272	4·77	347·35	11	
Winifred of Oakbank	W. G. Burgess ...	Ayrshire ...	6167	6 10	29-6-23	273	8,475	4·02	341·07	8½	
Lux of Yarralla	D. J. Goyder ...	Jersey ...	6825	6 0	21-8-23	273	7,143	4·66	333·50	15½	
Lady Betty II. of Koogan ...	A. W. Padbury ...	Guernsey...	872	5 7	13-6-23	273	7,685	4·33	332·99	18½	
Lady of Inglewood	D. Malcolm ...	Jersey ...	5910	6 2	12-11-22	273	5,898	5·62	331·46	5	
Dorinda 4th of Dardanup ...	P. Rose	do. ...	9993	6 7	1-4-23	273	5,715	5·50	314·38	17	
Creamy of Dardanup	R. H. Rose ...	do. ...	8941	5 0	25-10-22	273	6,197	4·99	309·44	16	
Yarraview Isabel	A. W. Padbury ...	Guernsey...	397	6 0	11-6-23	273	6,238	4·77	297·86	19	
Lady Fowler II. of Dardanup ...	R. H. Rose ...	Jersey ...	10003	7 0	7-11-22	273	6,252	4·65	290·63	17½	
Antimony's Elvira	T. L. Rose ...	do. ...	8465	10 8	13-4-23	273	5,142	5·61	288·67	6½	
Mokine Picotee	Walker & Co. ...	do. ...	8486	6 3	10-8-23	243	5,135	5·61	288·55	5	
Jessiemia XI. of King's Vale ...	**D. Malcolm ...**	**do. ...**	**6339**	**5 11**	**29-6-23**	**273**	**6,510**	**4·36**	**284·14**	**10½**	

Purity of Gowrie Park ...	W. G. Burgess ...	Ayrshire ...	4915	6	3	5-10-23	213	6,463	4·25	274·95	11	
Belverdere 5th of Dardanup ...	P. Rose	Jersey ...	8925	7	10	21-8-23	213	5,797	4·59	266·31	10	
Marge of Oakbank	W. G. Burgess ...	Ayrshire ...	6161	6	10	8-6-23	243	6,043	4·41	266·52	4½	
Quality of Oakbank	do.	do. ...	6163	6	8	16-6-23	273	7,042	3·70	260·87	12½	
Golden Bell of Roelands ...	A. H. Henning ...	Jersey ...	10117	6	5	5-8-23	153	3,538	5·73	202·99	20½	Sold.
Blossom II. of Merridale ...	P. Rose	do. ...	8927	5	2	7-12-23	153	2,862	5·13	146·87	11	Withdrawn.
Lady of Moorlands	P. Rose	do. ...	8938	5	4	1-1-24	120	2,670	5·01	133·92	19	do.
Carlotta of Ventonia	T. L. Rose ...	do. ...	8467	10	3	30-10-23	33	1,221	4·28	52·34	37	do.
Dorinda IV. of Dardanup ...	P. Rose	do. ...	9993	7	6	9-3-24	30	915	4·82	44·16	30½	do.

SENIOR 4 YEARS OLD (OVER 4½ YEARS AND UNDER 5 YEARS)—STANDARD 325 LBS. OF BUTTER FAT.

Lady Fowler 9th of Dardanup ...	T. L. Rose ...	Jersey ...	10008	4	9	30-6-23	273	9 838	4·98	489·95	20	
Flavoria of Banyule	Dept. of Agriculture	do. ...	8489	4	11	19 3-23	273	7,908	5·92	468·55	19	
Girlie of Sarnia	D. Malcolm ...	do. ...	9992	4	8	20 7-23	273	9,180	4·85	446·01	23	
Fairy of Dardanup	R. H. Rose ...	do. ...	8942	4	11	10-12-22	273	8,305	4·75	395·05	27½	
Lydia 5th of Yarralla	D. J. Goyder ...	do ...	6826	4	11	28-6-23	273	7,044	5·08	357·77	15	
Milton's Rosebud	A. W. Padbury ...	Guernsey...	500	4	9	17-9-23	273	7,255	4·72	342·89	15	
Myrtle of Merridale	P. Rose	Jersey ...	8928	4	8	15-6-23	243	4,828	5·44	262·85	11½	
Milkmaid 1st of Blackheath ...	H. O. Timms ...	M.S. ...	10091	4	11	17-6-23	243	6,428	3·84	247·25	8½	
Retford Tessie	W. Padbury ...	Jersey ...	8464	4	6	10 10 23	183	2,952	5·53	163·28	9	

JUNIOR 4 YEARS OLD (OVER 4 YEARS AND UNDER 4½ YEARS)—STANDARD 300 LBS. OF BUTTER FAT.

Tipperary Mona	W. G. Burgess ...	Ayrshire ...	6165	4	3	14-6-23	273	6,568	4·88	320·58	10	
Twylish Madeira of Roelands ...	D. Malcolm ...	Jersey ...	6832	4	1	5-8 23	273	5,356	5·77	309·08	10½	
Lady of Moorlands	P. Rose	do. ...	8938	4	4	1-1-23	273	4,644	4·74	220·14	11½	
Tiny of Grass Vale	R. H. Rose ...	do. ...	...	4	2	25-7-23	63	2,392	5·33	127·56	38½	Sold.

SENIOR 3 YEARS OLD (OVER 3½ YEARS AND UNDER 4 YEARS)—STANDARD 275 LBS. OF BUTTER FAT—273 DAYS.

Boronia of Grass Vale	R. H. Rose ...	Jersey ...	9994	3	11	15-8-23	273	8,091	5·06	410·11	26	
Favourite of Roelands	D. J. Goyder ...	do. ...	6819	3	9	17 3-23	273	7,697	5·02	396·37	22½	
Mokine Lady Noble	Walker & Co. ...	do. ...	10633	3	7	12-8-23	273	6,190	5·88	364·27	16	
Gladys of Roelands	D. J. Goyder ...	do. ...	6821	3	7	10 5-23	273	5,763	5·33	318·93	10	
Yarraview Georgina	A. W. Padbury ...	Guernsey...	782	3	7	28-5-23	273	5,763	5·24	297·04	14	
Rena II. of Gleneira	W. G. Burges ...	Ayrshire ...	8519	3	11	14 8-23	273	5,653	5·09	288·13	6½	
Pride of Moorlands	P. Rose	Jersey ...	8940	3	10	20-6-23	123	1,899	5·78	109·00	12	
Mamselle Mimi of Hamel Lea...	A. H. Henning ...	do. ...	10046	3	7	24-10-23	63	1,765	5·16	91·12	27½	Sold.
Lass of Moorlands	P. Rose	do. ...	8939	3	9	29 3 24	30	645	4·38	28·26	21½	Withdrawn.

JUNIOR 3 YEARS OLD (OVER 3 YEARS AND UNDER 3½ YEARS)—STANDARD 250 LBS. OF BUTTER FAT.

Rhodora II. of Dalebank ...	D. Malcolm ...	Jersey ...	8451	3	1	4 9-23	273	6,286	5·79	364·01	14½	
Daisy of Garden Hill	W. Padbury ...	do. ...	1628	3	3	16 6-23	273	5,785	6·18	357·95	14½	
Boronia of Grass Vale	R. H. Rose ...	do. ...	9994	3	2	9-10-22	273	6,675	4·94	330·07	20	
Lass of Moorlands	P. Rose	do. ...	8939	3	0	4-6-23	243	4,917	5·44	284·81	9	
Wisteria II. of Homeleigh ...	D. Malcolm ...	M.S. ...	N.Y.A.	3	5	19-5-23	273	6,184	3·94	243·85	9	
Modest II. of Homeleigh ...	do.	do. ...	N.Y.A.	3	1	12-2-23	183	3,426	3·49	119·69	14½	
Blossom of Moorlands	P. Rose	Jersey ...	8926	3	3	31-1-24	60	1,440	5·84	84·00	23	Withdrawn

HERD TESTING: Official Results since 1st July, 1923 continued.

Name of Cow.	Owner.	Breed.	Herd Book No.	Age.		Date of Calving.	No. of Days in Test.	Weight of Milk for Period.	Average Test.	Total Butter Fat.	Weight of Milk Last day of Test.	Remarks.
				Yrs.	Mths.			lbs.	%	lbs.	lbs.	
SENIOR HEIFERS (OVER 2½ YEARS AND UNDER 3 YEARS)—STANDARD 225 LBS. OF BUTTER FAT 273 DAYS.												
Jean II. of Grass Vale ...	R. H. Rose ...	Jersey ...	9996	2	9	23-5-23	273	8,701	5·81	508·93	31	
May of Blackheath	Wooroloo Sanatorium	M.S.	N.Y.A.	2	7	23 6 23	273	10,065	3·84	386·56	30½	
Mokine Empire's Lily V. ...	T. H. Wilding ...	Jersey ...	10635	2	10	20-6-23	273	5,725	6·67	382·09	18	
Mokine Empire's Lily VI. ...	do.	do. ...	10636	2	8	6-5-23	273	6,120	6·21	380·59	20½	
Fuchsia III. of Glencira ...	W. G. Burgess ...	Ayrshire ...	8514	2	10	15-6-23	273	6,813	4·52	307·89	11	
Mamselle Mimi of Hamel Lea ...	A. H. Henning ...	Jersey ...	10046	2	9	23 12-22	273	5,166	5·37	277·85	10½	
Gem of Moorlands	P. Rose	do. ...	8937	2	11	9-7-23	273	5,161	4·86	251·17	9	
Dairymaid 6th of Glencira ...	W. G. Burgess ...	Ayrshire ...	8513	2	11	28-7-23	273	5,770	4·12	238·05	11	
Virginia of Nundorah	A. W. Padbury ...	Guernsey...	778	2	7	29-5-23	273	3,941	5·34	210·56	13	
Thelma of Blackheath	H. O. Timms ...	M.S. ...	12847	2	7	29-3-23	243	5,063	4·03	204·50	5	
Myrtle of Moorlands	P. Rose	Jersey ...	8929	2	8	30-6-23	93	1,978	5·10	100·95	16½	Withdrawn.
JUNIOR HEIFERS (UNDER 2½ YEARS—STANDARD 200 LBS. OF BUTTER FAT 273 DAYS.												
Lady Fowler 14th of Dardanup	R. H. Rose ...	Jersey ...	12093	1	11	30-8-23	273	7,220	5·38	388·37	26½	
Lily of Grass Vale	do.	do. ...	8947	2	5	2-2-23	273	7,482	5·00	374·63	30½	
Lady Fowler 12th of Dardanup	do	do. ...	10011	2	4	24-3-23	273	6,970	4·75	332·25	24½	
Lady Fowler 17th of Dardanup	do.	do. ...	11695	1	11	17-8-23	273	5,766	5·75	331·64	20	
Lady Fowler 13th of Dardanup	D. Malcolm ...	do. ...	8986	2	4	26-6-23	273	7,036	4·43	312·15	15	
Girlie II. of Sarnia	do.	do. ...	11633	2	0	14-1-23	273	7,140	4·13	295·36	23	
Dunalister Manakin's Peree's Capture II.	R. H. Rose ...	do. ...	10392	1	11	1-8-23	273	4,730	5·99	283·76	15½	
Milton's Daisy II.	A. W. Padbury ...	Guernsey...	922	1	8	31-3-23	273	5,515	5·47	278·37	20½	
Pet VIII. of Glenira	D. Malcolm ...	M.S. ...	N.Y.A.	1	9	28-2-23	273	3,802	4·67	270·98	18½	
Alice of Blackheath	Wooroloo Sanatorium	do. ...	N.Y.A.	2	5	15-7-23	273	6,616	4·29	264·66	16½	
Picton's Trequean Flirt ...	A. W. Padbury ...	Guernsey...	747	2	1	15-4-23	273	5,566	4·74	264·20	22½	
Pride of Blackheath	Wooroloo Sanatorium	M.S. ...	N.Y.A.	2	1	6-4-23	273	7,049	3·73	263·52	21	
Lady Fowler 18th of Dardanup	T. L. Rose ...	Jersey ...	12830	1	10	28-7-23	243	4,650	5·58	259·90	17	
Mokine Noble Lily	Walker & Co. ...	do. ...	11795	1	7	16-6-23	273	4,872	4·99	243·22	13	
Blossom of Moorlands	P. Rose	do. ...	8926	2	3	1-3-23	273	4,476	5·27	236·20	14½	
Beauty of Sarnia	D. Malcolm ...	do. ...	12086	1	9	27-5-23	273	3,860	5·91	228·29	11	
Fancy's Pride of Ventonia ...	T. L. Rose ...	do. ...	12829	1	8	18-7-23	243	4,417	5·03	223·47	13	
Lily of Roelands	D. J. Goyder ...	do. ...	10619	2	3	9-11-22	273	4,881	4·43	216·64	11	
Jessimia of Sarnia	D. Malcolm ...	do. ...	12088	1	11	3-8-23	273	4,293	4·67	200·64	10	
Banker II. of Moorlands ...	P. Rose	do. ...	N.Y.A.	1	10	13-8-23	213	3,253	4·98	162·28	10	Withdrawn
Honey of Blackheath	H. O. Timms ...	M.S. ...	11766	2	5	7-4-23	243	4,428	3·60	159·78	5	
Maid of Moorlands	P. Rose	Jersey ...	N.Y.A.	1	7	15-8-23	213	3,129	4·84	151·67	5½	
Tipperary Wendy	W. G. Burgess ...	Ayrshire ...	8520	2	0	1-8-23	63	1,449	4·90	57·17	13	
365 DAYS TEST.												
Jean II. of Grass Vale ...	R. H. Rose ...	Jersey ...	9996	2	9	23-5-23	365	11,181	6·04	676·22	24	

KIKUYU GRASS FOR POULTRY.

Geo. L. Sutton,
Director of Agriculture.

Any easy way of supplying the essential greenstuff to their stock is sure to appeal to poultry-keepers, and in the hardy and vigorous Kikuyu Grass (*Pennistum clandestinum*), either irrigated or on moist ground, a means of doing this has evidently been found. The experience of Mr. A. A. Lightfoot, "Onkaparinga," Thirlmere Road, Mt. Lawley, with his small plot of irrigated Kikuyu grass is illustrative of this. During the early part of September last year Mr. Lightfoot obtained a small parcel of Kikuyu runners and roots—about 150 pieces—from the Chapman Experiment Farm. These were duly planted in two or three rows along one side of a small yard about 12 yards long and six yards wide. Only about 10 per cent. of these grew. It is believed the reason for the small percentage striking root was due to the fact that the cuttings were placed loosely in the soil, and not packed by tramping as they should be.

Kikuyu Grass at Mt. Lawley. Poultry cutting their own greenstuff.

The plants which struck were kept well supplied with moisture by overhead sprinklers, and, by the end of October, they had made fair growth, and at this time the fowls accidentally obtained access to the grass. Though other greenstuff was available they preferred the Kikuyu, and ate it bare, and to such an extent that it was thought the plants had been killed. This, however, was not so; the plants soon revived, and, with the advent of warmer weather and abundant moisture, they threw out runners so freely

that in a few months practically the whole area was covered a little irregularly with grass about a foot high. The grass at this time could have been cut and fed to the 50 hens for which it was intended, but with the object of avoiding this labour of cutting, it was decided to divide the yard into two portions, and allow the fowls to have access to one until the grass was eaten down, and then to give them access to the second half, and shut the first half up to permit it to grow again in readiness for the time when the second yard had been eaten down. This plan was put into operation during the first week of February, but the fowls have not yet exhausted the resources of the first yard. The condition of the grass in the yards early in the first week in May is shown in the illustration. The light dropper fence separating the two yards, and the height of the grass—18 inches to 24 inches—can be seen in the background. When just turned on to the grass the fowls only had long shoots to feed upon, but as the first of these were eaten down it became apparent that they prefer the short young grass to the older and longer shoots. In consequence, they have kept the front part, shown in the foreground of the illustration, eaten down so that it has become a very close thick sward.

The behaviour of this grass during the brief period referred to indicates that Kikuyu grass under irrigation is hardy enough to stand the constant picking of fowls without injury. In this respect it has an advantage over lucerne, which is not hardy in the same way, but, in order to be utilised to the best advantage, requires to be mowed at certain periods of its growth.

Similar results were obtained under irrigation at the Chapman Experiment Farm in 1922. This Kikuyu plot in November, 1922, presented an area of bare ground with here and there struggling lengths of the grass. As the result of being watered, the same plot, by the middle of January, was covered with a rank growth of succulent grass about 18 inches high. Samples of this grass were air-dried (made into hay), and sent for analysis to Dr. Simpson, the Government Mineralogist and Analyst. The result obtained is as hereunder. As a matter of interest analyses of Lucerne Hay and Paspalum Hay, as found by the Agricultural Chemist in New South Wales, are also given:—

The Composition of Lucerne Hay, Kikuyu, and Paspalum Dilatatum.

	Lucerne Hay. N.S.W.	Kikuyu Grass. W.A.	Paspalum Dilatatum. N.S.W.
Water	10.0	7.6	10.6
Ash	8.9	9.4	6.4
Crude Protein ..	16.0	17.4	10.3
Crude Fibre ..	24.6	22.1	28.3
Carbo Hydrates ..	37.7	42.4	43.4
Fat	2.8	1.1	1.3

As the composition of plants varies, amongst other things, with the period of maturity at which it is cut, and as details of the other fodders on this point are not available, an exact comparison is not possible between them and Kikuyu grass.

Neither is there any data available regarding its digestibility, but it is not unreasonable to assume that the digestibility of this, like that of any other young grass, is also good.

Altogether, as the result of the experience of it with the poultry referred to, and also with other stock, combined with the information supplied by the analyses made here and elsewhere, there is justification for considering the Kikuyu grass of entirely satisfactory nutritive value, and therefore quite as suitable for supplying the needs of poultry for greenstuff as any other fodder.

Because the grass is hardy enough to stand the constant picking which it receives from fowls, it is believed that it affords to keepers of poultry for commercial, as well as domestic use, a cheap method of providing succulent green feed with a minimum of labour, if suitable facilities of duplicated yards in sufficient number to meet the requirements of the flock are provided. The fowls, if allowed to graze upon it, will cut their own greenstuff.

Those who wish to plant this grass are reminded that seed is not produced by the plant except in its native State, and then only very scantily, and it is therefore propagated from roots or runners. When runners are used for planting these can be cut up into pieces containing two or more joints from which, under suitable conditions, roots are sent out. It is believed that these pieces, if ploughed into moist land, will grow, and this will probably be found the most suitable method of planting large areas. For small ones, however, it is recommended that the pieces of runner be dibbled into the prepared ground just as cabbages are planted; the necessity for pressing the planted portion well into the soil by means of the foot, or by some other means, is emphasised.

Under irrigated conditions planting can take place at any time during the year, and as the Kikuyu grass is heat-loving, the spring is best; but under natural conditions planting during autumn, after the rains have started, is recommended, so that the grass may become rooted and established before the dry summer conditions are experienced.

FLAG SMUT OF WHEAT.

(*Urocystis tritici.*)

W. M. CARNE,

Botanist and Plant Pathologist, Department of Agriculture,

FLAG SMUT,

frequently misnamed "Black Rust," is one of the most serious diseases of wheat. It is possibly even more serious in Australia than Stem Rust, inasmuch as it takes its toll every year, while rust is bad only in occasional years. Where the disease comes from we do not know. It may be native to Australia. Known in Australia at least as far back as 1868, it has since appeared in Japan, India, South Africa, Southern Europe and, as recently as 1919, in the United States of America. In Western Australia its occurrence has been apparently quite recent, and so far it has only been traced back to 1921.

CROP LOSSES DUE TO FLAG SMUT.

Every State in Australia is now known to be affected. Of recent years the disease appears to be increasing in severity, especially in Victoria and New South Wales.

The losses resulting are due to one or more of the following reasons:—

1. Killing of plants.
2. Dwarfing of plants.
3. Failure of plants to form ears normally.

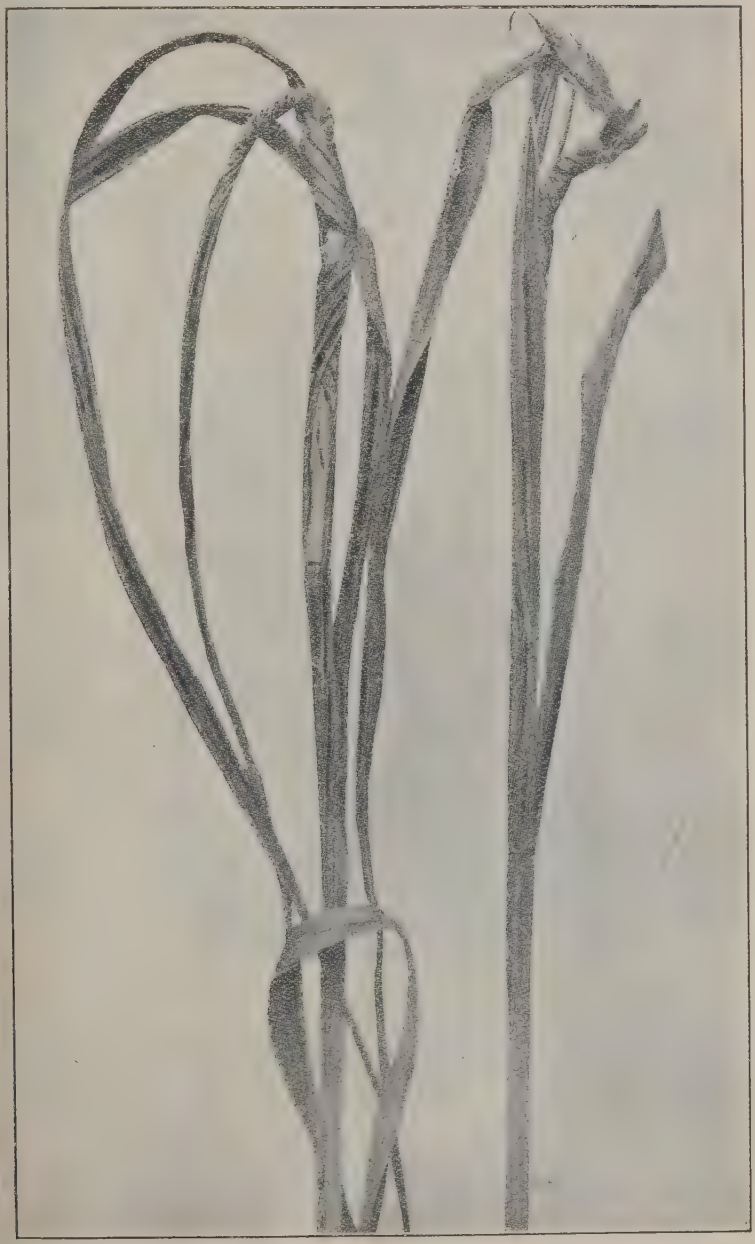
Thus the yield of both grain and hay is reduced.

It is estimated that Australia loses on the average 3 per cent. of its grain yield each year. Losses of 10 per cent. or more are not uncommon in South Australia, New South Wales, and Victoria. In the latter State up to 70 per cent. of infection has been recorded in individual crops.

FLAG SMUT IN WESTERN AUSTRALIA.

Flag Smut is not yet prevalent in this State. It has been recorded from Belka, Yelbeni, Tammin, Yorkrakine, Quairading, Merredin, Korbel, Nungarin—all in the centre of the wheat belt. It has been traced back to 1921; and the farms then affected were still affected in 1923. It is possible, of course, that the disease occurred earlier, and was overlooked.

So far the damage reported has not been great, and has been estimated to be less than one bushel per acre. Nevertheless, we have no reason to suppose that the disease, if neglected, will not spread and become general, as it has in recent years in New South Wales and Victoria. Now, while it is still not widely spread, there is good reason to believe it can be checked. This requires careful watch and good farming. Even an average loss of half a bushel per acre would mean about 800,000 bushels on last year's figures alone. Western



Flag Smut of Wheat.
(After McAlpine.)

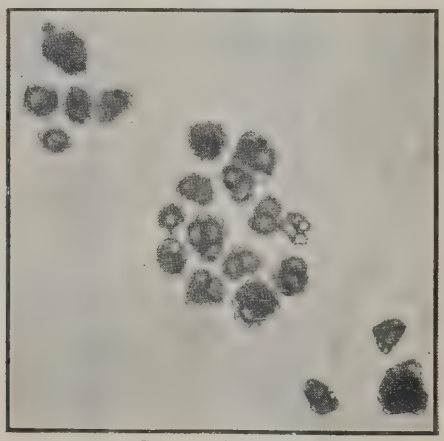
Australia is very fortunate in its relative freedom from disease. It depends largely on our farmers and their methods of farming whether we will continue to be so fortunate.

HOW TO RECOGNISE FLAG SMUT.

The leaves and leaf sheaths become curled, twisted, and distorted. Together with the stems they develop long black streaks running parallel with the veins. The streaks are due to ruptures or slits caused by the fungus, and from them comes the black powder or smut from which the disease gets its name. The affected parts may become quite blackened, and the smut may even penetrate the hollow centres of the straw. Affected plants are either killed or stunted. Whole stools may be smutted or only some of the shoots, the remainder forming normal but undersized ears with little or no grain.

THE CAUSE OF THE DISEASE.

The cause of the disease is a fungus parasite known scientifically as *Urocystis tritici*. The black powder which forms on the affected parts consists of its minute spores or seed bodies. Under the microscope these spores differ from those of the flying and stinking smuts, as they are enveloped in a protective covering of bladder-like appendages. Under favourable condi-



Spores of Wheat.

tions the spores germinate and produce a short growth on which are borne several secondary spores. It is by these latter that wheat is infected. Infection may take place either from spores adhering to the seed or from spores in the soil. Infection can only take place on the young stem below ground in the seedling stage, or on young shoots arising from below ground. It is probably complete in the former case, and may only be partial in the latter.

The spores do not germinate readily under normal conditions, and many may survive a number of seasons in the soil. Dr. R. J. Noble, of New South Wales, has recently shown that germination is stimulated by the roots of

plants, not only of wheat, but also of other crop plants. It is probable (the matter is still under investigation) that the growing of crops other than wheat, especially when they are fed off or ploughed in, will greatly help in controlling the disease in affected paddocks by inducing the spores to germinate. It is necessary to get the spores to germinate while there is no wheat crop to attack, so that they may die from starvation. Therefore the practice of using change crops such as oats and peas in rotation with wheat, a practice which has proved its value in the production of grain and the control of Takeall, is also advisable to control Flag Smut.

HOW INFECTION IS CARRIED.

Wind is probably the principal method of spreading the disease from paddock to paddock. Another important way is by the feeding of affected chaff or stubble to stock, which pass the spores uninjured to the soil. Men and animals may carry spores on their feet. Spores may be carried on seed, hay, or chaff from place to place. It is probable that the disease was brought to this State from the Eastern States on seed. Western Australia should grow its own seed wheat and oats and avoid introducing diseases from other States.

CONDITIONS FAVOURING THE OCCURRENCE OF THE DISEASE.

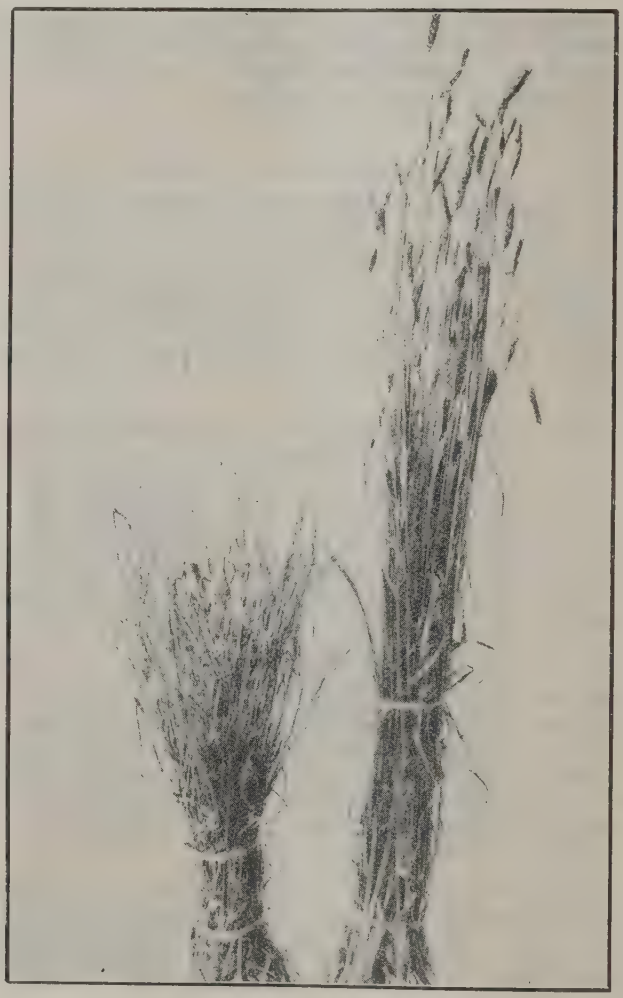
Flag Smut is more likely to be serious on heavy than on light soils, in self-sown crops, and in dry-sown than wet-sown crops. In this State it would appear to be worst on heavy clays in depressions. Flag Smut may be expected where previous crops have been affected, or when seed from affected crops is sown without treatment, and where stock are fed on diseased chaff or stubble.

Flag Smut is not to be expected on clean land sown with treated seed.

Dry sowing is dangerous in soils which have carried smutted crops. Reports from New South Wales show that this point was very marked last season. Dry-sown crops suffered much more than wet-sown on the same farm. The reason appears to be that in dry sowing both spores and seeds germinate together and the conditions are ideal for infection. In wet sowing many of the spores which germinate are likely to die before the wheat germinates sufficiently to be attacked.

Depth of sowing appears to be important, and an interesting case is reported from Barellan, in New South Wales, last season by Senior Instructor Shepherd: "A very interesting case was seen on one farm—not a competition crop. Two drills had been used in the sowing. Exactly similar seed and treatment had been adopted, but the crop that had been sown with one drill was very badly affected with flag smut, over 70 per cent. of the crop having been taken, while that sown with the other drill had only slightly suffered from the disease. This occurred right throughout the plot, every alternate width of the drill being as described. The explanation may be that the badly diseased crop was sown with a hoe drill, which put the seed in deep, right amongst the fungus spores, with the result that the wheat seed and the spores

germinated together. Hence the diseased plants. In the other case, a disc-drill was used, and only shallow sowing resulted, the seed thus being placed in soil that, owing to the working of the fallow after rain, should have been practically free from fungus spores. The moisture had germinated the spores,



Produce of one square yard with Flag Smut.

and the cultivation had killed them. The disc-drill also left the soil loose on the surface, and many of the spores may have germinated and perished, owing to unfavourable conditions and lack of moisture."

VARIETIES AFFECTED.

Little is known about the relative resistance of the different varieties. In the East, quick maturing varieties such as Florence are least affected. The longer season kinds are more susceptible, particularly Federation and Canberra. Smut has been recorded in Western Australia on Gluyas Early, Merredin, Florence, Nungarin, Newman's Early, and Belka; but more data must be collected before any conclusions can be made in regard to the susceptibility of the locally grown varieties.

Attempts are being made in the East, by crossing with certain immune hard red wheats, to produce resistant commercial varieties.

METHODS OF CONTROL.

Clean seed in clean ground is the best defence against Flag Smut. Should the disease appear on a farm, the following precautions should be taken:—

1. *To secure clean land.*—Harvest the affected crop for grain. Burn the stubble. Do not cut for hay, or allow stock on stubble. By these means the spreading of the spores will be checked to a large extent. Adopt a rotation, such as fallow, oats or grazing crop, fallow, wheat. Fallow early. Keep down self-sown wheat. If a crop follows affected wheat it should be used for feeding off, to prevent Flag Smut forming on self-sown wheat. By methods such as these the spores will be starved; but the interval between crops of wheat must be two years at least.
2. *To ensure clean seed.*—Treat all seed with copper carbonate, formalin, or bluestone and lime, as for Stinking Smut. This will kill any spores of Flag Smut which may be on the seed.
3. Sow in a moist seed bed when possible. In a dry autumn this may not be possible if the crops are to be sown in due season.

SUMMARY.

Flag Smut is one of the worst diseases of wheat.

Flag Smut is not yet prevalent in Western Australia, but may become so in a few years if neglected.

Experience in the East shows that Flag Smut may be controlled. Control will become more difficult every year it is neglected. Until recently Western Australia was the only State free from this disease. Good farming will help us back to this enviable position.

PESTS AND THE GROWER.

W. M. CARNE,
Botanist and Pathologist.

Farmers and fruit-growers have so many pests to combat that they are apt to feel at times as if all Nature was combined against them. Western Australia certainly has its dingoes, kangaroos, poison plants, insect and fungus pests. But how many West Australians realise how fortunate this State is as a whole in this regard compared with our Eastern neighbours.

We have no sparrows, and the rabbit, compared with the East, is still relatively scarce. But it is in regard to insect and fungus pests that we are most fortunate.

Western Australia is the only State or country growing apples commercially which is free from Codlin Moth. The growers in the other States must spray regularly or lose much of their crops. In some States spraying is compulsory. Phylloxera, the greatest insect pest of grape vines, is here unknown. In New South Wales and Victoria all vineyards must be worked on resistant stocks. Fruit Fly we have, but not the Peach Tip Moth which attacks stone fruits, apples, quinces, etc., in New South Wales, and is nearly as bad as the Fly. And there are more, such as the Apple-root Borer, Pumpkin Beetle, and the Vine Moth of the Eastern States, from which we are free.

Concerning fungus diseases, Western Australia is probably the only State growing apples commercially which has not Black Spot or Scab. This is usually regarded as the most serious disease of apples, requiring regular spraying, and even then in some years, as in Tasmania this season, it breaks away from control. Western Australia is the only commercial grape-growing State without Downy Mildew. This is the worst disease of grapes, and in Victoria and New South Wales regular spraying is essential for its control. It is the only stone fruit-growing State free from Brown Rot, the worst disease of stone fruits, which regularly claims its toll in the East, especially in the later varieties. It is practically free from Wheat Rust and Potato Blight, so that these diseases are rarely seen and still more rarely cause serious damage. Until a few years ago it was the only Australian State without Flag Smut of wheat. This disease is here now, though not very widely scattered.

The preceding facts are of great importance. They mean greater ease and lower costs of production and increased value to growers and State. It should be the pride as well as duty for every grower to help keep up this unique freedom from disease.

Diseases may come to this State from abroad or from other States. The Commonwealth and State, through the Quarantine Regulations and Plant Diseases Act, do their share of keeping them out. All plants, seeds, bulbs, etc., from abroad are inspected under the Quarantine Regulations. Trees and plants, bulbs, etc., are inspected and treated, if necessary, or condemned. Seeds are examined and treated, ordered to be recleaned, or condemned, as necessary. Apples, pears and quinces are totally prohibited, to keep out Codlin Moth. A similar prohibition is exercised against grapes (fruit, cuttings or rooted plants), except under certain conditions, from South Australia, as a precaution against Phylloxera. Prohibition exists as regards citrus fruits, apples pears, quinces, and stone fruits, gooseberries, walnuts, and potatoes, against

the introduction from countries affected with Citrus Canker, Fire Blight, Gooseberry Mildew, Walnut Blight and Potato Corky Scab and Wart diseases, respectively.

As against the other States we are protected by Federal quarantine and by the State Plant Diseases Act. All plants arriving are inspected and fumigated when necessary. All bulbs and tubers are inspected.

It is evident that so long as the laws are not evaded there is little chance of pests which can be detected being admitted. On the other hand, plants and fruit may come in in personal baggage without being detected. There are always people who, in ignorance or with a perverted sense of their responsibilities, try to evade the laws designed for the benefit of the country. A more important weakness in this system of control lies in the bringing in of seeds and plants carrying diseases which cannot be detected by inspection. This applies especially to fungus and bacterial diseases which may be only recognisable on growing plants and not on seeds, etc. Here is where the grower should help. By keeping his eyes open, and by reporting to this Department the occurrence of any pest new to him, he may enable it to be eradicated before it becomes thoroughly established, if indeed it does prove to be new. Further, he can help by purchasing his seeds and plants, so far as is reasonably possible, from West Australian sources. He then knows that they will have no diseases other than those already here. Particularly do these remarks apply to cereals. In the past few years two new diseases of wheat have appeared which were probably brought on seed from other States, namely, Flag Smut and Downy Mildew. That pests may be eradicated, if early taken in hand, is shown by the way the several outbreaks of Codlin Moth which have occurred in past years have been stopped. The occurrence of Flag Smut is an instance of what should not occur. It has been traced back for several years before it was first reported to this Department. At its first outbreak it might have been possible to eradicate it before it spread further. It may have even been confined to a single paddock. Now it is widely scattered through the wheat belt, and farmers who value clean crops must recognise its presence and adjust their methods to keep it in control. It has become another burden on the grower, though we cannot yet say how serious.

It is undoubtedly a fact that our dry summers and the general absence of muggy weather in the spring help considerably in checking the serious outbreak of disease. But we cannot rely on this. Many diseases occur in the wet seasons. Muggy weather in the spring does come sometimes. Some summer diseases do develop in spite of dry weather. This summer, one of the driest on record, has been accompanied by the plentiful occurrence of Scab or Fusicladium of the pear. Why should not Apple Scab, the cause of which is almost identical with that of Pear Scab, do the same if introduced here?

Our protection against new diseases lies in our climate, inspection by departmental and quarantine officers, and in growers who keep their eyes open and report the occurrence of new pests so that action may be taken to eradicate them before they become generally established. All must work together if we are to maintain our present unique distinction in regard to freedom from pests.

FARMERS' TRIALS, NORTHERN AND EASTERN AREAS.

H. RUDALL,
Field Officer.

A number of Farmers' Field Trials with wheat and oats were carried out last season at various centres, and while this single season's results can in no case be taken as conclusive, the results obtained year by year are always worthy of attention. The trial plots measured from a quarter to nearly half

Scrub land at Bencubbin on which Farmers' Trials are conducted.

Drilling Farmers' Trial Plot at Bencubbin.

an acre in area, according to the size of the drill, and each plot was duplicated to include the different varieties of soil. At each end and in the centre of all the plots a control plot was established. All seeding was completed by the end of May, the rate of seeding being 45lbs. for wheat and 40lbs. for oats, and that of super. 70 to 80 lbs. on the heavy land, and 100 lbs. on the sandy and scrub plain land.

WHEAT TRIALS.

Wheat trials for the Northern Area were carried out at Carnamah and Pithara on heavy land, while those for the Eastern Area were conducted at Koorda on heavy land, Bruce Rock and Kununoppin and Narembeen on scrub plain, and Wyalkatchem on sandy soil. In the table of results set out below it will be seen that the computed yields per acre of each variety ranged from 15 to 33 bushels on the heavy land, from 10 to 26 bushels on the scrub plain, and from 14 to 18 bushels on the sandy soil.

At Carnamah the yields of the Merredin and Yandilla King varieties were reduced owing to patches of seven yards and four yards in length, respectively, having been eaten off by stray stock. The yield of the Belka variety at Koorda would also have been greater but for the fact that the plot was attacked by the climbing cutworm while the heads were still in the "milky" stage. Rabbits were responsible for reducing the yield of one control plot of Nabawa variety at Wyalkatchem. The varieties Florence and Belka both suffered from an outbreak of Septoria. At Narembeen the varieties Nabawa and Nungarin were damaged by hail estimated to reduce the yield by at least a bushel per acre.

The yields returned from trial plots at Three Springs were not used for comparison, as no scales were available to weigh the grain, and the farmers' estimates of the results could not therefore be considered sufficiently reliable to be used as data. Another trial carried out by Mr. D. H. Faulkner, at Babakine, was not included in the table of results because the plots were not harvested in accordance with the conditions laid down for all the trials.

The individual computed yields per acre of the different varieties were as follow:—

Name of Farmer.	District.	Type of Soil.	Belka.		Carrabin.		Florence.		Merredin.		Nabawa.		Yandilla King.		Control Plots.	
															Yield	Variety.
			B.	L.	B.	L.	B.	L.	B.	L.	B.	L.	B.	L.	B.	L.	
Robertson, R.	Carnamah ...	Heavy	...		27	52	...		33	33	28	30	32	34	29	31	Gresley
Roach, S. G. ...	Pithara ...	do.	22	20	21	21	18	2	25	40	...		...		23	32	Canberra
Robinson, P. J.	Koorda ...	do.	15	56	23	16	15	32	26	15	...		...		19	7	Hard Federation
Butler, W. J.	Bruce Rock	Scrub plain	24	22	25	36	22	10	24	49	...		...		26	43	Gluyas Early
Appleyard, T. J.	Kununoppin	do.	15	22	15	48	10	14	19	43	...		...		12	17	Clarendon
Cockrane, R. M.	Wyalkatchem	Sandy	16	57	14	33	14	54	18	7	...		...		17	38	Nabawa
Nobles, F. ...	Narembeen	Scrub plain	...		...		13	6	17	6	17	21	13	26	12	4	Major
													*				

*Nungarin.

The following table shows the recorded rainfall for the year in each locality during 1923:—

District.	Useful Rains.											Nov.	Dec.	Total for Year.
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Total.			
Bruce Rock	48	110	38	159	157	517	107	86	231	33	1,131	...	239	1,725
Carnamah		No Records.			204	910			No Records.					
Winchester (9 miles from Carnamah)	40	6	54	210	125	737	231	66	70	25	1,234	...	...	1,564
Koorda	9	...	40	219	71	430	85	58	116	7	767	...	61	1,096
Kununoppin	32	105	41	138	67	400	67	81	110	22	747	...	88	1,151
Wyalkatchem	27	13	3	219	144	614	129	99	149	28	1,163	...	203	1,628
Bencubbin	25	64	57	191	67	371	178	38	136	4	794	...	239	1,370
Three Springs	16	66	5	147	84	799	300	105	108	30	1,426	...	...	1,560
Pithara	8	22	13	172	122	746	166	92	158	37	1,321	...	17	1,553
Narembeen	69	36	24	139	154	419	97	68	160	16	914	...	178	1,360

OAT VARIETY TRIAL.

It will be seen from the accompanying table that on the heavy land the acquitted yields ranged from 47 to 58 bushels, on the scrub plain from 16 to nearly 40 bushels, and on the sandy land from 7.5 to nearly 22 bushels.

Burt's Early Oats—Bruce Rock.

Ruakura Oats—Bruce Rock.

At Carnamah the Ruakura variety was allowed to stand too long before stripping and went down badly; and at Wyalkatchem the centre control plot (Algerian) was reduced in yield by rabbits.

At Three Springs the same remarks apply to the oat variety trial as in the case of the wheat.

At Babakin, and Mr. J. W. Kabl's, Kununoppin, the results cannot be given as the plots were not harvested according to instructions.

OAT VARIETY TRIAL.

Name of Farmer.	District.	Type of Soil.	Lachlan.	Burt's Early.	Ruakura.	Algerian.	Control.	
							Yield.	Variety.
			B. L.	B. L.	B. L.	B. L.	B. L.	
Appleyard, T. J.	Kununoppin	Scrub plain	16 25	26 16	26 35	...	16 5	Sunrise.
Butler, W. J.	Bruce Rock	do.	39 33	29 36	33 7	...	35 7	Algerian.
Glyde, K. S. ...	Three Springs	do.	...	26 39	30 0	37 39	16 27	Lachlan.
Hopwood, B. W. G.	Bencubbin...	do.	38 37	38 10	33 9	...	33 20	Algerian.
Cockrane, R. M.	Wyalkatchem	Sandy	21 35	16 23	18 34	...	15 21	do.
Robertson, R.	Carnamah ...	Heavy	26 28	26 17	...	34 11	17 32	Ruakura.

The following table shows the monthly useful rainfall:—

District.	May.	June.	July.	August.	Sept.	October.	Total.
Bruce Rock ...	157	517	507	86	231	33	1,131
Carnamah	...	...	...	...	...	...	...
Koorda	71	430	85	58	116	7	767
Kununoppin ...	67	400	67	81	110	22	747
Pithara	122	746	166	92	158	37	1,321
Wyalkatchem ...	144	614	129	99	149	28	1,163
Bencubbin	67	371	178	38	136	4	794
Three Springs ...	84	799	300	105	108	30	1,426
Narembeen ...	154	419	97	68	160	16	914

Burt's Early Oats—Merredin.

Ruakura Oats—Merredin.

CULTURAL NOTES.

Bruce Rock.—Ploughed end of July 1922; disc cultivated beginning October and beginning of March, 1923; twice during May on account of Stinking Roger. Sown third week in May with 45 lbs. wheat, 40 lbs. oats, and 100 lbs. superphosphate per acre.

Carnamah.—Ploughed end of August, 1922; grazed with sheep during September and October; cultivated middle of April, 1923, and again prior to seeding; sown on 25th April with 45 lbs. wheat, 40 lbs. oats, and 75 lbs. superphosphate per acre.

Koorda.—Ploughed in July, 1922; cultivated with spring-tooth twice in October, 1922, and April, 1923; harrowed May, 1923. Sown May 15th with 45 lbs. wheat and 75 lbs. superphosphate per acre.

Kununoppin.—Ploughed in July, 1922; cultivated with tandem disc in September, with spring-tooth in February, 1923, after rain, spring-tooth prior to seeding. Sown 4th May with 45 lbs. wheat, 40 lbs. oats, and 100 lbs. superphosphate per acre.

Narembeen.—Ploughed August, 1922, with a "Sundercut" disc and cross ploughed again a month later with the same implement. In March, 1923, again "Sundercutted" after a thunderstorm. Cultivated prior to seeding at the beginning of May. Sown with 42 lbs. wheat and superphosphate 100 lbs. per acre.

Pithara.—Ploughed middle of July, 1922, cultivated with spring-tooth end of August, disced September; spring-tooth February and April, 1923; harrowed after rain in April, 1923; sown 1st May with 45 lbs. wheat and 80 lbs. superphosphate per acre.

Wyalkatchem.—Ploughed middle July, 1922; cultivated spring-tooth beginning September, end of April, 1923, middle of May; sown 17th May with 45 lbs. wheat, 45 lbs. oats, and 100 lbs. superphosphate per acre.

Three Springs.—Ploughed in July, 1922; cultivated in August, October, 1922, and March, 1923; sown on 19th April with 45 lbs. wheat and 75 lbs. superphosphate per acre.

Oats.—Ploughed July, 1922, and cultivated prior to seeding; sown third week April with 40 lbs. oats and 100 lbs. superphosphate per acre.

FERTILISER TRIALS.

Fertiliser.	Computed yield per acre.	Cost per acre.	Yield.		Cost.	
			Increase.	Decrease.	Increase.	Decrease.
	bus. lbs.	s. d.	bus. lbs.	bus. lbs.	s. d.	s. d.
Mr. B. W. G. Hopwood, Bencubbin.						
Scrub Plain Soil.						
Super.	21 47	5 6	...	...	...	...
Super. and Potash ...	21 50	9 6	0 3	...	4 0	...
Super. and Ammonia	21 56	10 6	0 9	...	5 0	...
Super., Potash, and Ammonia	22 49	14 6	2 2	...	9 0	
Mr. W. J. Eva, Gutha.						
Heavy Soil.						
Super.	17 8	5 9	...	...	...	
Super. and Potash ...	15 22	9 9	...	2 46	...	4 0
Super. and Ammonia	17 4	10 9	...	0 4	...	5 0
Super., Potash, and Ammonia	17 38	14 9	...	0 30	...	9 0
Mr. W. J. Butler, Bruce Rock.						
Scrub Plain Soil.						
Super.	25 55	5 9	...	...	...	...
Super. and Potash *	28 48	9 9	2 53	...	4 0	
Super. and Ammonia	23 1	10 9	...	2 54	...	5 0
Super., Potash, and Ammonia	21 37	14 9	...	4 18	...	9 0
Mr. M. Cockrane, Wyalkatchem.						
Sandy.						
Super.	14 52	5 9	...	...	...	
Super. and Potash ...	12 12	9 9	...	2 42	...	4 0
Super. and Ammonia	15 3	10 9	0 11	...	5 0	
Super., Potash, and Ammonia	14 43	14 9	...	0 9	...	9 0

* One plot only.

Although the results of the trials carried out by Messrs. W. J. Butler and M. Cockrane are included, no consideration or value can be placed upon them, as at Bruce Rock two plots were badly eaten by rabbits and three others suffered from hailstorm, for which loss the insurance companies allowed two bushels to the acre. At Wyalkatchem several of the plots were reduced in yield by rabbits, two of them to the extent of two chains long. A careful perusal of the whole results, however, generally indicates in a marked degree the efficacy of superphosphate. The growing period was the same as for the wheat and oat trials, and the rainfall table (page 154), also applies to the fertiliser trials.

The rate of seeding and rate of superphosphate trials as carried out by Mr. J. Deane Hammond, of Kellerberrin, and Mr. W. J. Eva, of Gutha, were tabulated and commented upon in the April number of the *Journal*.

THE OBJECTS AND CONDITIONS OF FARMERS' TRIALS.

GEO. L. SUTTON,
Director of Agriculture.

For three years the Department of Agriculture has been carrying out trials on farmers' holdings. Prior to that Messrs. Teasdale Bros. of Cumberland Farm, Bedka, conducted similar experiments for about six years, the results of which were published by the Department. During the first year they were confined to the wheat belt and to trials with wheat and oats on light land, but since then their scope has been extended so that trials have been conducted throughout the agricultural area and on all kinds of soil.

All kinds of experiments are not suitable for the farmers to carry out. A farmer is a commercial man, engaged in a business for the profit there is in it, and all experiments are not directly profitable; therefore any experiment carried out by a farmer, except in a public spirited way, must be of such a character that the experiment is of special interest and that the results will be of *direct* benefit to him. Unless this be so the experiment may be neglected on some occasion when it interferes with some of his multitudinous duties which are directly profitable. Willing acknowledgment is made of the public spirited attitude of farmers in Western Australia who have undertaken experiments in the interest of their district rather than of special value to themselves, but the general principle underlying these trials is that they are of benefit to the experimenter himself as well as to his district.

One of the objects which the departmental officer has in visiting the applicant for these trials is to ascertain what problems are of special interest to him, with a view to solving them and planning the trial to suit the implements and other conditions obtaining on the farm. For example, in the wheat belt it has been found that the size of the plot most suited for the implements particularly the drill in use ranges from a quarter to half an acre. In the South-West dairy belt the plots are smaller.

Typical trials of direct value to the wheat farmer are variety trials whereby he can determine with some degree of accuracy whether a new variety of wheat or oats is more suitable for his requirements than his old favourites, or this simple trial may be slightly elaborated so that he may determine which type of wheat or oats is most suitable for his conditions.

A typical trial of direct value to the dairy farmer is a fodder trial to determine, say, whether Sudan grass or maize is most profitable or otherwise more suitable for his conditions.

Experiment work requires a certain amount of additional care and labour. The experience of the Department over a number of years has, however, reduced this to a minimum, and with the assistance rendered by the supervisor in laying out the plots the extra work devolving upon the farmer is not very great and is felt principally at harvest time when the different plots require to be dealt with separately.

Any farmer desirous of having any trial carried out on his holding is requested to make application to the Director of Agriculture, Perth, giving details regarding the problems of interest as well as concerning the location.

character, and condition of the land. Because of the public interest which attaches to any of these experiments it is desirable that where possible the land on which they are planted should be easily accessible.

In the wheat belt proper one of the essential conditions is that the experiments shall be on properly fallowed land; and in this area it is desired that the applications be sent in early. The closing date for applications is 1st September, 1924.

The conditions under which farmers' trials are conducted are as follow:—

1. The Department of Agriculture will send an officer—
   (a) to visit the district;
   (b) to ascertain the type of trial to suit the need of the individual case;
   (c) to select the location on which the trial is to be carried out;
   (d) to arrange details relating to the conduct of the trial;
   (e) To assist in laying out the plots, assist in the planting and supervise the same.
2. The Department will supply—
   (a) seed of varieties in the variety trials other than the control varieties;
   (b) when desired the seed required for Rate of Seeding and Rate of Superphosphate trials;
   (c) The fertilisers other than superphosphate required in the fertiliser trials;
   (d) the necessary plot labels.
3. The whole of the produce from the trial plots will be the property of the farmer.
4. The farmer will be required to provide the land, and transport the Supervising Officer from and to the railway station.
5. The farmer will be required to carry out the work of preparing the land, and the sowing, cultivation and harvesting, with his own labour and implements, according to instructions supplied by the Department.

THE INCUBUS OF THE DAIRYING INDUSTRY.

G. K. Baron-Hay, B.Sc. Agri.,
Agricultural Adviser, Dairy Branch.

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The period between November and April is characterised in the butter factories of this State by the large quantity of second-grade cream that is received. The rainfall during this period is at its lowest throughout the cream-producing districts, and as a consequence something like 75 per cent. of the second-grade cream received during the whole year is then marketed. This estimate has been ascertained after a careful examination of the records kept by the various factories. The loss to suppliers is, in the aggregate, very considerable, and the most serious phase of this loss is that the bulk of it falls upon the small suppliers, from whom most of the second-grade cream is received. The effect is far-reaching, and concerns the State as well as the dairy farmer, resulting as it does in the production of, and sale of, quantities of inferior butter.

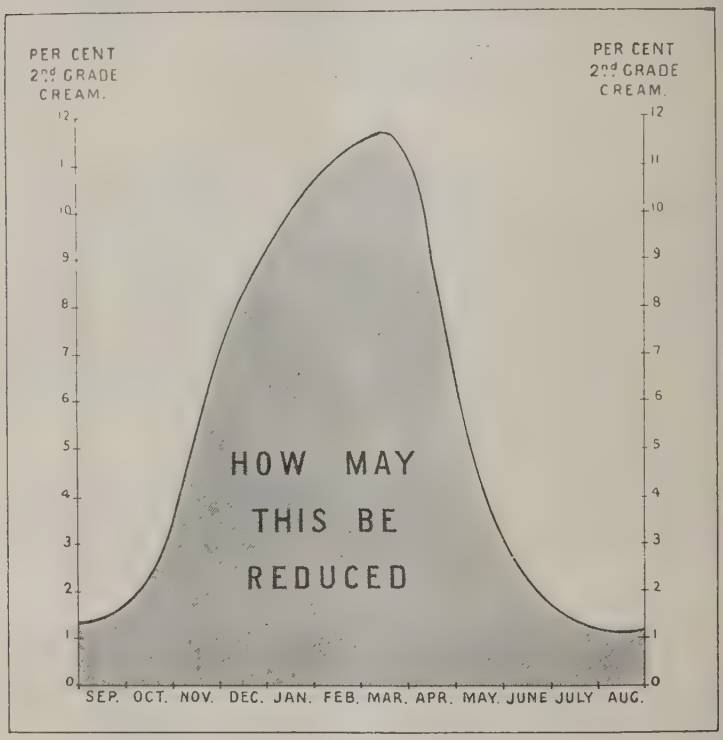
The primary cause of second-grade cream is due to lack of permanent pastures and fodder crops, which take time to establish, but there are other causes which to a great extent are within the control of the dairyman. These may be classified as faults in texture and faults in flavour, all of which it is possible to obviate by the exercise of care and attention to necessary details in the dairy.

During the season when grass is plentiful the supply of second-grade cream is reduced to a minimum, but its occurrence is due chiefly to limited appliances in the dairy, and the failure to observe certain well defined rules. This is more particularly the case with the dairyman who produces only a small quantity of cream weekly, and disposes of it to the factory.

Numbers of farmers make their own butter and dispose of it to private customers at a price that compares favourably with good factory butter. In those cases it is generally found that they are careful to produce a good quality cream. A great many, however, make an inferior quality of butter, which is sold in the metropolis and in country towns at a price very much below that obtained for the factory-made article. In these cases the difficulty usually lies in the fact that with limited appliances and means of cooling, it is almost impossible to manufacture a butter that will keep for any length of time; and a fruitful cause of the deterioration is neglect or inability to pasteurise the cream. Were it supplied to the factory, where it could be properly treated, the dairyman would probably receive a good price for it, but by making it into butter himself, he succeeds only in producing an inferior article for which he receives a correspondingly low return.

With the advent of summer and the increasing lack of good pasture or fodder crops these difficulties are accentuated, and the percentage of second-grade cream increases by leaps and bounds. The accompanying graph strik-

ingly exemplifies this, and the purpose of this article is to show how this incubus of the dairying industry—as it is aptly termed—may be reduced, if not altogether abolished.



The texture of cream is a most important factor. "Washy" cream having a test of less than 30 per cent. of butter-fat ferments very quickly in the summer. The ripening and acidity is produced by bacterial organisms which exist on the non-fatty portion of the cream, and in a thin or "washy" cream this ripening process occurs rapidly. When a certain stage of acidity has been reached the beneficial bacteria cease to grow, and deleterious bacteria commence to thrive, producing taints which render the cream second-grade. "Washy" cream is also liable to be partially churned when being transported to the factory, rendering it difficult to obtain an efficient sample.

On the other hand, cream containing more than 46 per cent. butter fat is liable, during the winter months, to ripen too slowly to produce a good quality butter, and therefore should not be sent to the factory so thick. If creams of different ages are mixed they should be thoroughly stirred, and this is impossible if the test exceeds 46 per cent. Consequently portion of a can's contents may become second-grade, and this causes the full contents of the can to be similarly classed. In addition to this moulds thrive on the surface of insufficiently stirred cream and cause further deterioration.

"Lumpiness" in cream is caused through running the cream from the separator immediately into a can already containing cream. The result is a thick lumpy cream which cannot be satisfactorily sampled at the factory, and this of course is detrimental to the producer. Cream should not be mixed until it is cold, and should then be well stirred if lumpiness is to be avoided.

Cream for the factory should return a test result of from 40 to 43 per cent. butter fat in summer, and 35 to 37 per cent. in winter, and dairy farmers will be wise to bear this fact continually in mind.

Faults due to flavour are due to two causes—(a) physical or chemical, or (b) biological or bacterial.

Physical or chemical changes are the result of various factors. Many weeds, such as wild mustard, stinkwort, wild pennyroyal, King Island melilot, wild onion, and others, while harmless to the cows as herbage, give to the milk a decided and generally unpleasant taint which acts detrimentally. Several cultivated fodders, among which are rape and turnips, have a similar effect. The best remedial measure to take where the pasture is thus affected is to remove the cows three or four hours before milking time. It is, however, chiefly during the spring months that taints arising from this cause occur. Then again the atmospheric surroundings are often responsible for tainted milk or cream. Either is capable of absorbing taints from strong-smelling foods, etc., such as bacon, apples, or cheese, and care should always be taken not to store milk or cream near anything of a strong-smelling nature. Cream in cans which are exposed to the hot sun will also develop a "metallic," "tallowy" taste. It may be due to the fact that the "tinning" of the can has worn off, or to the oxidisation of the butter fat contained in the cream. In either case the defect may be obviated by the cream cans being shielded from the rays of the sun, or by covering them with moist bags.

The biological or bacterial faults are chiefly the result of unclean dairy methods. Much of the bacteria in cream is beneficial, but there are also groups of deleterious bacteria that produce gas, and the signs of gas invariably indicate that there has been a want of cleanliness somewhere in the handling of the milk between the time it was drawn from the cow and it reached the cream can. Milk or cream thus affected ferments very rapidly, and is invariably detected and graded second-class immediately on arrival at the factory, with unsatisfactory results for the producer. The obvious remedy is absolute cleanliness in every detail in the dairy, and the supply of cream showing a test of from 40 to 42 per cent.

Mealiness is another common fault in thick creams. A thick cream ripens slowly. In the earlier stages it proceeds in the usual way, the lactic acid being produced by beneficial bacteria. After a time, however, the cream becomes so acid that these bacteria can no longer function, and deleterious bacteria which exist on the casein come into operation and impart to the cream a mealy taste, which at a later stage develops into an unpleasant cheesy taste.

This fault largely occurs in the cream sent into the factory by small suppliers. For the purpose of economy in transport the cream is thickened so that perhaps a full week's product may be contained in one can, with the result that it develops mealiness and a cheesy flavour, and in addition is too thick to be properly stirred either at the farm or in the factory, thus

preventing a proper sample being taken. Cream should not be kept for a longer period than three days before being despatched to the factory, and the dairyman who has only a small weekly yield of cream will be well advised to send it along in at least two lots, giving a test of 40 per cent. The higher grade thus obtained will more than recompense him for the extra trouble.

The foregoing facts are mainly responsible for the quantity of second-grade cream which reaches the factories during the summer months, but, as the article attempts to show, there is no valid reason why the evil should continue. Dairy-keepers have but to exercise care and attention in the handling of the dairy product, exercise the most scrupulous cleanliness, and be guided by well defined rules regarding storage, pasture feeding, and testing, and the excessive quantity of second-grade will be reduced to a minimum, while the increased profit to the dairy-farmer will be correspondingly increased.

A RAPIDLY INCREASING PEST.

The Government Entomologist (Mr. L. J. Newman) has thought it advisable to issue a warning note regarding the alarming spread of the Red Legged Velvet Earth Mite (*Notophallus bicolor*) (Frog.).

This pest attacks all kinds of garden plants, vegetable and clover crops. It is particularly damaging to the plants belonging to the leguminosæ, such as peas, beans, clover, lucerne, etc. The mite is a tiny creature, about one-tenth of an inch in size, the mouth parts and legs being bright red and the body a deep velvety blue. To date its ravages are confined mainly to the light coastal sandy lands. The means of spread into new or clean districts is per medium of seedling plants.

It is against the practice of purchasing seedlings promiscuously without ascertaining that the garden is free from this scourge that I desire to warn the public. This especially applies to new areas or areas not already invaded by the mite. As this plant destroyer cannot fly its spread is slow, unless aided artificially by the carriage of infested seedlings. It is one of the most destructive of our winter vegetable feeding pests, and most difficult of control.

For fuller particulars apply to the Department of Agriculture for Bulletin No. 106, which contains preventive and remedial measures.

THE USE OF THE SCYTHE.

H. Campbell,
Government Gardener.

The scythe is a most useful implement to have on the farm, or for use in the garden, but it is now only used where the areas are too small to warrant the purchase of expensive machinery. Almost every man who owns a horse or a cow and grows a bit of feed will find it useful, particularly in the winter seasons when good grass grows in reserve corners where it is not convenient or advisable to allow the animals to feed. The scythe is better adapted for mowing this grass than any of the more modern implements. Good service might also be done with the scythe on many holdings in clearing out rank growths of grass, etc., in places inaccessible to mowing machines or ploughs when making firebreaks.

Fifty years ago, before the advent of machinery, the scythe was the most valued of all the implements used by the agriculturists. Skill in its use has, however, through the introduction in recent years of cheap labour-saving machinery, become almost a lost art. Every man working on a farm or in a garden was taught from his boyhood to handle and swing a scythe, and usually his greatest pride lay in the manner in which he could cut a swath and lay his straw straight and neat for his lifter. The latter was generally a woman, and it was her pride to point to the scytheman who made her labour easy. An entirely different opinion was held of the man who took no pride in his work. He would throw his scythe around carelessly, and, by allowing the point of the blade to shoot through the newly laid straw, or by kicking up the heel of the blade as he brought it round, would lay some of the heads of corn where the butts should be. This man made extra labour for his lifter, who had to put the straws straight before making them into a sheaf. He was stigmatised as a man who had no mercy for a woman.

Many men to-day say they can use a scythe, but those who can do so skilfully are few and far between. The writer commenced using a scythe when he was 14 years of age. At that time a good day's work was two acres in a standing crop of wheat, or on rye grass hay, and one acre was as much as any man could do on meadow hay. But none of these is as difficult to mow as short grass. That is where the expert scytheman exhibits his skill. Out of a hundred men who can mow long grass, the majority are unable to cut short grass without showing scythe marks on it. If asked for the reason of their failure they are unable to give one. There are several reasons.

In the first place the man has not learned to set his scythe blade into the sned. When this is done properly it means that the mowing is accomplished with more ease, and is done twice as well. A scythe may be set to cut a light, medium, or heavy crop, the cutting edge being placed in an oblique position so that it severs the stems of the plants with greater certainty, acuteness, and freedom than if the cut were horizontal.

The character or style of scythe is determined by the nature of the ground on which the crops or grass are grown. For instance, a long and

almost straight scythe may be used where the paddock or garden is level and unbroken, but where it is uneven and rough a short and somewhat curved scythe is most suitable.

The scythe consists of two main parts, the blade and the snath or sned (the curved wooden handle), (Fig. 1), to which are affixed two movable hand grips. A "grass nail," hook or stay from the sned to the blade is also usually

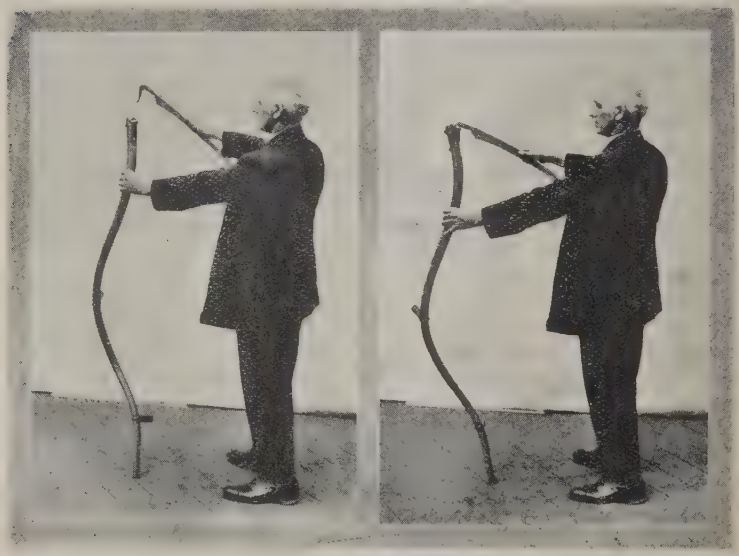


Fig. 1.—Attaching the blade to the "sned."

affixed. This, while acting as a stay, prevents the stalks of the grass or corn from catching in the short space between the end of the blade and the sned, and thus necessitating a heavier pull when completing the swing. It is easily

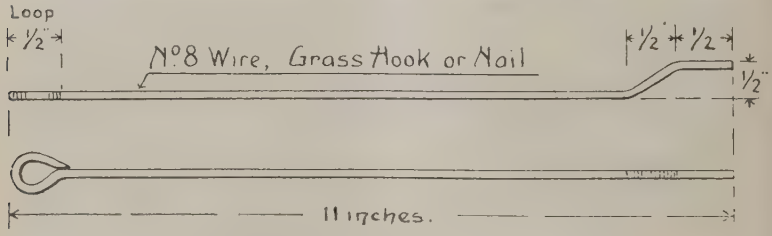


Fig. 2.

made from a piece of No. 8 wire, and is about 12 inches long. (*See* Fig 2). One end of the "grass nail" is inserted in the small hole found in the end of the blade near the heel, and the "nail" is then laid diagonally from the blade to the sned, to which the other end is fastened by a screw or nail.

The "heel" is a lug at the end of the blade, and is attached to what is termed the "socket" in the sned. The heel requires to be bent to a certain angle, according to the class of mowing which is to be done (Fig. 3). This angle is decided by the mower, but it is such that, when the blade has been fastened to the sned and the mower is holding the scythe in the attitude for cutting, the edge of the blade should, if mowing either wheat, hay, or long grass, be about one inch above the level of the ground. When lawns or short grass are being mown, the elevation is about half an inch. The "heel" may be bent either by placing it in a vice and bending it cold—which, however, is a risky proceeding, as it is liable to snap—or it may be heated and then bent. In the latter case it is advisable to keep the blade cool by means of a wet bag or something similar, so that the temper of the steel shall not be destroyed or injured. If a further slight alteration in the elevation of the edge is required, a satisfactory adjustment may be made by wedging a piece of leather in between the heel and the sned where the former enters the socket. The socket adjustment (see Fig. 4), enables the scytheman to alter the sweep of his blade, so that he can with equal facility cut a broad or narrow sward. The operation of adjusting the blade to the proper elevation is termed "setting" the scythe. The relative position of the point, in order to regulate the radius of the sweep when making the swing, is determined in several ways. One of the most common methods is that shown in the illustration (Fig. 5). The sned is held against the body, so that the handle in the right hand is held against the right thigh, and the right leg is extended. If the toe of the boot reaches the point of the scythe, it is a guide that a correct sweep of the blade will be obtained. The hand grips on the sned must be placed in correct position to insure a well-balanced movement. The hand grip for the right hand should be so transfixed and adjusted that, when taken up on the index finger, it will balance and hang evenly. Each grip is screwed to a ring which encircles the sned, and the mower, if he finds them awkwardly placed, has merely to unscrew them sufficiently to loosen the ring, move them to the required position and tighten the ring again. The thread of the screw is made to work in the opposite direction to mower's grip, thus keeping the grip ring tight.

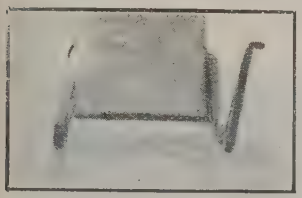


Fig. 3.—The "heel." The left-hand figure shows a scythe blade heel as purchased; the right-hand one is bent for use.

Fig. 4.—The socket adjustment, to set the blade for a broad or narrow sward.

When mowing, the man should place his legs wide apart so as to bring his back into the best position for it to exercise its strength, for mowing should be done by means of a body stroke rather than by the arms. The arms should act chiefly as guiding or connecting rods between the man and the scythe in the same way as a skilled oarsman exerts his powers from the back and by the use of his legs, instead of pulling the stroke through with

Fig. 5.—Determining the correct position of the point for a good sweep.

his arms. Young beginners make the stroke with the left hand too far in advance of the left leg, which should be a little in the rear of the right. After the first half of the stroke the left hand should be drawn sharply round and near to the left leg. It is want of attention in this particular that causes the chief difficulty. Care must be taken that the point of the blade is in a direct line with the heel of the mower's right foot (see Fig. 6) when in the attitude of cutting. When the first movement is made, and on finishing the swing, the heel of the blade should be in a line with the heel of the left foot (see Fig. 6). Otherwise it will be found that the blade does not cut too

cleanly; it will come too much broadside on, and will pull rather than cut the grass. The beginner will find this somewhat difficult, and it will be advisable for him to first practise swinging his body as though cutting with the scythe. The left hand, kept on the handle, must be opposite the left hip-joint, and maintained firmly in this position during the progress of the blade in the swing round until finished. If this position is not rigidly maintained the point of the blade, instead of cutting cleanly from point to heel right through the

Fig. 6.—The swing of the scythe.
The beginning. The end.

radius of the swing, will get out of line and stick in the ground, or will drag and fail to cut. When he has sufficiently mustered the movement he should then attempt cutting, at the same time moving forward. Properly done, he should be able to swing within a cutting radius of from 7 to 9 feet, and with each swing advance from 6 to 12 inches. When mowing lawns or light crops, it is necessary to keep the back of the blade on the ground from the commencement to the end of the swing. The point curves slightly upwards, and it will be found in practice that by keeping the back on the ground, the edge automatically remains at the proper height for making a close cut without allowing the point to stick in the soil.

The blade must have a good edge. It does not matter how well a man can "lay" a scythe in: if the blade has not a good edge he will find that considerably greater exertion is necessary to cover a given area of ground.

Putting a proper edge on the blade requires care and experience. The edge of a new blade is usually too thick and should be ground down. What is termed a "long edge" should be obtained, that is, the bevel from the sharp edge back towards the centre of the blade should be even and long, without exhibiting a shoulder at the beginning of the bevel. One method of sharpening the blade after grinding is to place the point in the grass (*see*

Fig. 7) on the left-hand side, grasp the heel firmly with the palm of the left hand and with the right work the scythe stone, which is about 14 inches long. Keep it flat on the blade and avoid turning the edge. The last stroke of the stone should always be on the side which hugs the sward. When using the stone to sharpen the point, slide the hand half-way down the blade and rest the elbow against the blade to keep it rigid. The sliding stroke downwards acts on the edge of the blade and converts it into a series of minute teeth like a saw and provides a keen cutting edge. The sharpening operation commences at the heel and proceeds evenly downwards until the point is approached; when the blade has to be raised and supported to sharpen the final few inches the strokes are shorter and sharper with the stone (*see* Fig. 7). Care should be taken to obtain sharpness on the point. Pass

Fig. 7.—Sharpening the scythe from the heel to the point. The strokes should overlap and finish on the back.

the thumb gently along the whole edge of the blade to ascertain if the edge be equally keen all through. The stone should be laid flat on the blade, and downward sliding strokes made evenly on both sides. If the stone is laid hard on the blade and tilted the resultant edge is short, and shows a distinct shoulder at the point where the bevel commences, and a "short edge" is the result. A "long edge" lasts longer and cuts better, while a short edge wears off quickly and necessitates frequent applications of the blade to the grindstone for the purpose of grinding down the "shoulder."

Other methods are sometimes adopted. The old Scottish method is to firmly grasp the blade under the arm-pit and rest the weight of the body on the upturned sned: then use the stone as already stated, commencing at the

point and working back to the heel. The finish of the sharpening stroke thus always finishes on the already sharpened edge. Another method is to hold the up-turned scythe in front of the body, grasping the point of the blade with one hand and sharpening by an up and down movement with the stone on either side alternately. The method of obtaining a "long edge" applies, however, in every case.

The best stone to use for sharpening the blade is a baked Waterloo sandstone, which produces a sharp smooth edge. A carborundum stone, while perhaps a little quicker in its effect, produces a rough edge which does not cut as cleanly and does not last as long.

Though the use of the scythe has been generally discontinued, there are still several skilled scythemen in the State. They are chiefly employed as gardeners, and exercise their skill on lawns and bowling greens, in public and private enclosures. After securing a scythe and attempting to set and use it, a learner should endeavour to obtain a practical lesson from and some practice with one of these skilled men. On the grain farm, of course, the scythe has been displaced by machinery. In the old country, however, even where machinery is used, the first width of the crop is still opened up by means of the scythe to allow the machine to go in without destroying any of the crop. Here this precaution is not taken, and this width is usually wholly or partially destroyed.

WHEAT YIELDS COMPETITION.

Extended reference was made in the April number of the "Journal" to the wheat yields competitions which have been initiated by the Department of Agriculture in co-operation with the Royal Agricultural Society and the two fertilising companies operating in this State (Cuming, Smith & Co. Ltd. and Mt. Lyell Chemical Works). Since then the Director of Agriculture has had leaflets printed setting out the objects and full details of the Competition, and these have been "broadcasted" throughout the State by every available medium.

As entries for the competitions close on 30th June, attention is again drawn to the matter. Farmers are reminded that there are three zones, in each of which prizes are awarded annually for the three years ending 1926, and at the end of that period a Championship Cup, value £20, will be awarded for the whole period in each zone. The entrance fee is 5s., which must be posted to the Secretary, Royal Agricultural Society, Queen's Buildings, William Street, Perth, on or before the specified date.

The object of the competitions is, briefly, to induce farmers throughout the wheat-growing areas of the State to show by the productivity of their farms what their districts can produce.

HORTICULTURAL AND VITICULTURAL NOTES.

GEO. W. WICKENS.

Officer in Charge Fruit Industry.

Seasonable Work for July, August, and September.

JULY.

Growers of apples, pears, stone fruits and grapes will find most of their time occupied this month in pruning, and so far as fruit trees are concerned there are nearly as many styles of pruning as there are operators, each exponent claiming some special benefit accruing from the procedure he follows. It is certainly a fact that, provided soil and climatic conditions are suitable, fruit trees will produce crops of fruit under the most varied methods of training, and with little or no training at all, but there are certain fundamental principles underlying pruning which should be mastered by the beginner, and having grasped these and acquired the habit of closely observing results from year to year he will find he is able to train his trees satisfactorily and obtain good crops even though his style differs somewhat from orthodox methods. One piece of advice I would like to give here is that every grower should have a settled system and follow it. I do not, of course, mean that he should perform all the work himself; that would be impossible in some of the large orchards, but he should be able to tell his men how he wishes the trees to be pruned, and see that they are done in that way, for although as stated above, there are many styles giving good results, sudden variations from year to year, when different pruners with divergent views carry on the work, are decidedly hard for the trees and costly to the owner.

There are many who have embarked in the industry during the last few years with little or no knowledge of the habits of the trees from which they hope to derive a livelihood, and I would strongly advise these to get in touch with the Orchard Inspector who supervises their particular district and request him to give a practical demonstration on their own trees, illustrating the best way to prune them. The Inspectors have had long experience in this work and know the habits of the trees under the conditions obtaining in the various fruitgrowing portions of the State, and a beginner will learn more in a couple of hours from seeing the work done and having an explanation of why it is done than he will from a week's study of a text-book. As he gains in experience he will find that a good text-book is a very valuable aid, but the complete novice finds it hard to recognise from the description given on the printed page the various buds and growths on the actual trees.

Orange growers will be busy this month with export, but they must find time to pay special attention to the fruit fly traps advised to be used in the notes for June in the last *Journal*.

Planting vines and deciduous trees should be pushed on with during the month.

AUGUST.

Pruning and planting deciduous trees and vines should be completed by the end of this month, and wherever the soil is dry enough spring ploughing should be in full swing. The second winter spraying for

San José scale should be completed before the 31st on all trees where the buds are forward. Late blooming kinds, like Rome Beauty and Five Crown apples, may be left until the middle or end of September.

Where old apple and pear trees require working over to other varieties, the necessary scions should be secured early in this month from trees thoroughly dormant, and buried in soil in a cool place to retard bursting of the buds.

Sultanas, Waltham Cross, Red Malaga, Ohanez and other varieties of vines subject to attack by *Anthracnose,* should be treated with very strong Bordeaux Mixture, 20lbs. lime, 20lbs. bluestone, 40 gallons water, just when the buds are nearly ready to burst; this treatment to be followed up in severe cases by a second spraying, at half that strength, about 3 weeks later; and a third at the ordinary strength of 6lbs. bluestone, 4lbs. lime, 40 gallons water, about a fortnight after the second. The need for the second and third sprayings depends upon the severity of the diseases and the weather conditions. If the spring sets in dry, the third spraying will not be required, and perhaps not even the second.

Until the last few years, the treatment recommended was swabbing with sulphuric acid, diluted with water, or sulphate of iron wash, but such success has been met with in the Swan vineyards with heavy dressings of Bordeaux Mixture that swabbing even in very bad cases is now rarely resorted to.

The weather will probably be still too unsettled to change from traps to baiting for fruit fly in orange groves, so the work of renewing the pollard mixture and carefully and regularly freeing the traps from leaves and other debris must be continued.

Orange aphis will appear about the end of this month, and where the insects are sufficiently numerous to damage the young shoots they should be sprayed with Black Leaf 40 and soap, using 1lb. Black Leaf 40 and 3lbs. soap in 80 gallons of water.

SEPTEMBER.

The first ploughing should be finished early this month and the cultivators brought into use. No grower can afford to risk putting off cultivation in the expectation of good rains falling in the late spring. Last season was a case in point, when practically all useful rains in the fruit-growing areas ceased about the first week in October. Dry winters are practically unknown in those areas, and provided the land is kept in a thoroughly tilled condition, even in as dry a summer as the last one, sufficient moisture can be conserved in the soil to enable the fruit to attain good size and quality, but where cultivation is neglected the fruit is undersized, lacking in juice and poor in appearance.

In districts where Pear Scab (*Venturia pirina*) is prevalent it is imperative that the first spraying with Bordeaux mixture—6lbs. bluestone, 4lbs. lime and 50 gallons of water—should be applied during the pinking stage of blooming; that is, when the majority of the blossoms are showing as a pink bud and when only a few have burst into petals. If this time of spraying is missed any number of sprayings later in the season will not give a good result. In many districts in this State in ordinary seasons the pinking stage spray is all that is required, but when wet weather continues a second spraying, after the fruit has formed, becomes necessary, using the same mixture, and in abnormal seasons even a third may be needed some time later. When

this last occurs, lime sulphur, at a strength of 1 gallon in 40 gallons of water, should be used, because Bordeaux applied at that stage of the fruits' growth may cause russeting.

Woolly Aphis should be treated this month with Black Leaf 40 and soap, but where parasites (*Aphelinus mali*) have been liberated, every care must be taken to leave without spraying a number of trees on which the parasites have been seen during the past summer or winter, so as to give this newly introduced enemy of Woolly Aphis every chance to increase in numbers.

Where powdery mildew of apple trees was in evidence last year spray with Atomic Sulphur, 1lb. in 10 gallons of water, after the petals have fallen.

Where old apple and pear trees require working over to other varieties, grafting should be done during this month; in most districts in the South and South-West the stocks will not be sufficiently forward until after the 15th. There are many methods of grafting, but strap grafting is the best. If any one desires to use it and does not know how to prepare the stock and scion, ask the district orchard inspector for a demonstration.

The planting of citrus trees should be completed this month and every care taken after they are received from the nurseries to prevent the roots from being exposed to the sun or drying winds.

Orange Aphis needs continued attention this month or it will, where numerous, destroy the blossoms and thus prevent fruit from setting.

Fruit flies will now be feeling the effect of spring weather, and baiting in orange groves should be carried out every ten days; while fallen fruits, especially mandarins, which are more subject to attack than oranges, should be gathered from the ground at least three times a week (every day is better) and all infected fruit boiled.

Where necessary, continue treating vines for *Anthracnose*, as advised under work for August.

PUBLICATIONS RECEIVED.

The Department of Agriculture of New South Wales has issued a 76-page Bulletin on "Spraying," which contains a good deal of valuable information on the subject of dealing with fungicides and insecticides. It is noted with interest that the experiments carried out by the officers of our own Department are being recognised by the New South Wales Department. The poison baits and trapping methods for fruit flies, etc., evolved after much experiment by Mr. L. J. Newman, this Department's Entomologist, and published in his Bulletin on the Fruit-fly, have been almost entirely adopted by the compiler of the Bulletin (Mr. W. J. Allen) and form the concluding chapter of the publication.

The first number of the "Empire Cotton-growing Review," the quarterly journal of the Empire Cotton-growing Corporation is to hand. It is published in London, and the contents include articles regarding cotton-growing in Tanganyika, in East Africa; the Imperial College of Tropical Agriculture; an appreciation and summary of the work on cotton done by William Robson, Curator of the Botanic Station, Montserrat, during the period 1905-1923; Cotton-growing Statistics; Notes on Current Literature; and the Indian Central Cotton Committee.

CO-OPERATIVE BAITING FOR THE CONTROL OF FRUIT FLY.

Geo. W. Wickens,

Officer in Charge Fruit Industry.

Fruitgrowers within that portion of the State where Fruit Fly (*Ceratatis capitata*) is prevalent will remember with interest particulars which were published in the Press last year of the success met with by the fruitgrowers at Spearwood, 1922-23 season, in joining together to combat the pest. For many years previously severe losses had been sustained annually by some growers in the district named, and some losses by all growers, the severity of the loss in each case being governed by the amount of care taken by the grower concerned in baiting his trees and destroying infected fruit.

Individual effort, taking the district as a whole, having given poor results, the Orchard Inspector, Mr. Simmons, who is a member of the Spearwood Fruitgrowers' Association, brought the matter up at one of their meetings and urged that a trial should be made co-operatively. The fruitgrowers at Spearwood are a progressive body of men, and though some doubt was expressed at the time the scheme was propounded of its practicableness, in a very short time after its initiation every grower had linked up. In consideration of the experimental nature of the work and its value to the industry, if successful, the Minister for Agriculture agreed to find the money for purchase of bait and allow Mr. Simmons, who originated the idea and was mainly responsible for working out necessary details, to closely supervise operations and act as secretary to the committee appointed to handle the matter.

As is well known, the venture was an entire success, and when the question of baiting for season 1923-24 came up for consideration it was found that districts adjoining Spearwood desired to link up with the co-operative movement, and finally a Board was formed representing Spearwood, North Lake, Coogee and Hamilton Hill, embracing an area of approximately 33 square miles and containing 132 separate orchards. Most of these are small places for in the districts mentioned all the holdings are small, but when the final tally for the season was made it was found that about 14,700 trees had been baited, at a cost which, including everything (labour, bait, stationery, postage, etc., only amounted to £67 17s. 7d. The work was done by one man, who provided his own horse and cart and was paid 25s. per day.

The baited trees comprise stone fruits, pears, apples, quinces, figs, loquats, oranges and lemons; the work was started in October and continued until the last of the stone fruits were gathered on 1st April. The members of the Board of Management have decided during this winter, when through heavy rains baiting becomes ineffective, to use pollard traps, and they hope by so doing to prevent a carry-over of the pest to next season. Of the four districts mentioned—Spearwood, North Lake, Coogee and Hamilton Hill—only the last named suffered any commercial loss of fruit during the time baiting was in progress. At Spearwood, North Lake and Coogee the losses were confined to a few fruits, and it is noteworthy that an old grower many

years resident at Coogee states that previously to this year he had never known a season in which he had not lost through fruit fly a big proportion of his mid-season and late stone fruits, apples, pears and quinces. This year he had practically a clean crop of all kinds and varieties.

Hamilton Hill is situated quite close to Fremantle, where there are many backyard gardens, and the mid-season and late fruits in orchards nearest the town became badly infected in spite of baiting, evidently owing to an influx of flies from the town gardens.

Following on the success of the Spearwood experiment in season 1922-23, meetings were held in various centres last winter, at which the writer outlined to the assembled growers details of the work performed and results obtained. Three districts—Bedfordale, Armadale, and Guildford—formed committees in each centre, and commenced co-operative baiting for fruit-fly in October. Bedfordale met with a very great measure of success, while Armadale and Guildford were practically failures. The reason for failure is not hard to find. Bedfordale growers, like the Spearwood growers, are obtaining their livelihood from the land, and fruit is one of their staple products, so in addition to baiting they attended regularly to picking up all fallen fruits, while at Armadale and Guildford there are many suburban homes with a few trees which produce fruit solely for home consumption and, with the exception of what this saves in the housekeeping expenses, they have no commercial value. Positive proof is afforded by these places that baiting alone will never prevent fruit fly from causing serious losses. Fallen fruit must be gathered from the ground daily and all infested fruits destroyed. With one female fly, capable of laying up to 300 eggs, a few neglected infested fruits will yield sufficient to stock an orchard, and it is futile to deliberately rear flies and then hope they will partake of poisoned bait and die before they cause damage.

In quoting the suburban homes and small gardens I am giving what I consider one of the main reasons of the non-success. Unfortunately, the suburban householder was not the only negligent person, as there were some commercial orchardists who, although in the baiting scheme, did not give the man engaged to do the work a free hand, but as the fruit ripened, asked him to miss particular trees, stating as a reason for doing so that it would soon be gathered; others apparently asked that some trees should be missed for no other reason than the very short-sighted one of saving the immediate small expense of treatment, while incurring a future comparatively large one in loss of fruit.

Ten years ago, when baiting was not practised, fruit fly threatened to become a serious menace to the whole fruit industry and had spread to practically every important fruit growing centre; but with the knowledge we now possess of methods of treatment there is no fear of the pest becoming a scourge throughout the State. In fact, for the past eight years it has not been recorded in the large fruit producing areas south of Bunbury, on the South-Western line, and south of Narrogin, on the Great Southern, but within 80 miles of Perth it must always be recognised as a serious factor and consistently fought against. In that area there is never a day in the year when there is not some kind of fruit on the trees to serve as a host, and there is never any winter weather so harsh that it will annihilate the insects, but with baiting, trapping, gathering fallen fruits, and destroying by burning all found to be infested, losses through fruit fly can be kept down to negligible proportions.

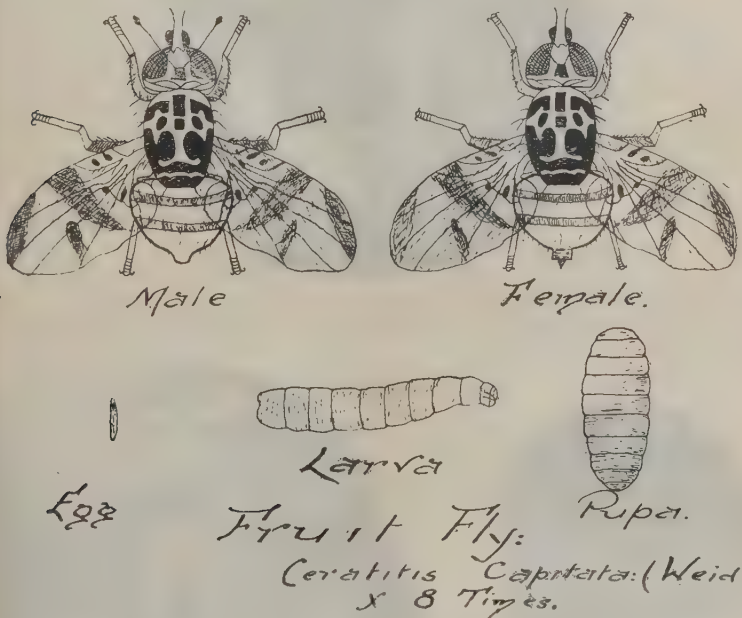
WINTER TRAPPING OF THE FRUIT-FLY.

(*Ceratitis capitata*) (*Weid.*)

L. J. Newman.

Entomologist, Department of Agriculture.

After the commencement of the winter rains, the foliage baiting for the control of Fruit-fly is rendered largely ineffective owing to the frequency of the showers, which wash the bait off.



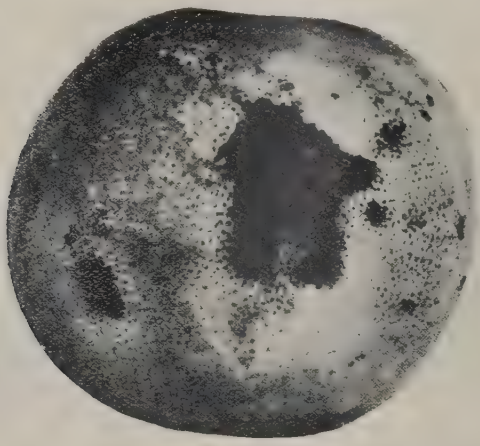
Life Cycle of Fruit Fly (original).

Imago or Adult, natural size.

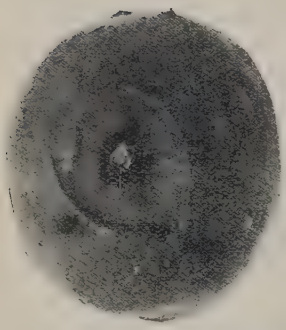
However, should a fine period set in during this season, it will always pay to apply the foliage bait to citrus and loquat trees.

In working out the life history of this insect we have proved an active winter generation, which carries the fly into the oranges and loquats, and thus the living connection between the autumn and early summer is bridged.

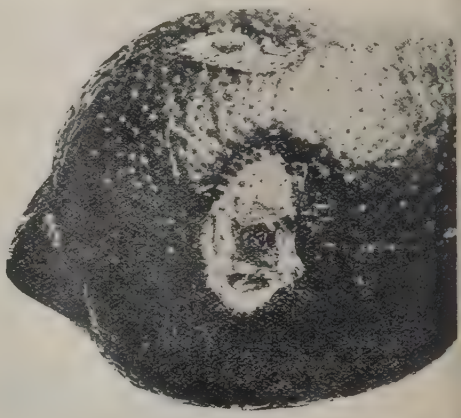
WINTER HOST FRUITS WHICH ARE THE MEDIUM FOR CARRYING OVER THE FRUIT-FLY FROM AUTUMN TO EARLY SUMMER.



Orange showing typical fly punctures and resultant brown patches.



Eggs in Loquat Fruit.



Eggs in Lemon.

For several years experiments have been conducted with the object of discovering an attractive lure or bait that could be used in traps, at any season of the year, but especially during the wet season.

It was a local discovery that kerosene or petroleum oils exercised a very peculiar attraction over the Mediterranean fruit-fly.

The first captures led us to believe that a successful lure had been discovered. Upon going more carefully into the nature of the capture and counting the sexes of the flies it was found that no less than 90 to 95 per cent. were males.

This was most disappointing, and led to the abandonment of the kerosene lure after being enforced for twelve months.

Having proved the attractiveness of kerosene to the male fly, it was decided to continue this form of experiment in the hope that some lure might be discovered that would attract the female fly. To this end the relative capturing values of several oils, including tar oil, oil of rodium, clove oil, whale oil, and citronella oil were tested.

The evidence forthcoming proved the kerosene the most effective from an attractive point of view. The counting of the sexes, however, still gave a great preponderance of males, and for this reason the oils tested were likewise abandoned.

It is difficult to answer the oft-repeated question as to what stimulates the male fly to commit suicide in the oil. The opinion is ventured here that this is probably due to the smell of the oil resembling or approximating the odour given off by the female to attract the male. The giving off of sexual odours by insects is a well recognised and established fact, but whatever the explanation of the phenomenon is the fact remains that the male fly is captured in large numbers by the use of volatile oils.

As it was the females we were desirous of attracting and capturing, further experiments were continued in which fruit juices and many other substances mixed with water were used. After almost exhausting all possible attractive mediums the writer found that pollard mixed with water proved a most remarkable attraction to the female fruit-fly.

After our experience with the kerosene oil, it was decided to test this formula thoroughly before making any public statement. This bait or lure, in traps hung in the trees, was tested over a period of twelve months and proved to be most successful. The pleasant odour emanating from the pollard, when mixed with the water, seems to be irresistible. Immediately the bait is mixed and placed in the traps the flies can be seen making towards it from all directions. They are so enticed that, after flying to the edge of the vessel, they dive straight into it and are drowned.

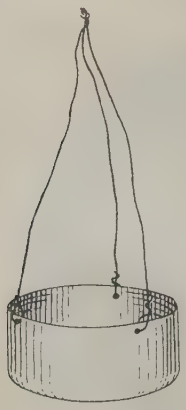
Contrary to our findings when using the kerosene lure, I found that females greatly predominated, no less than 86 per cent. being of that sex.

Examinations of hundreds of the females so captured were made, revealing the fact that they were fertile and full of eggs.

As an instance of the effectiveness of this lure the following is a good example:—

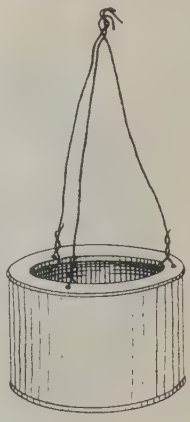
On the 8th May, 1923, twelve 10oz. lever-lid tin trays were placed in six orange trees in a suburban garden. In each tree two traps containing the pollard lure were hung, the lure being renewed every seven days. The positions selected for the traps were the north-east and north-west sides of the tree.

The period over which the test extended was from the 8th May to 3rd September—roughly four months. The number of flies captured totalled no less than 6,500, 86 per cent. being egg-laden females. The pest was practically wiped out from this garden by means of the lure, and from the



1

Smooth-edged tin not recommended



2

Marginal edged or lever tin as recommended.

3rd September until the first week in January no flies were captured. From then onwards the fly has been coming into this garden from other contiguous areas where summer baiting and trapping has been neglected.

The chief difficulty is in preserving the pollard solution from fermenting, when it becomes much less attractive to the fly. To overcome this it has been found advisable to add powered borax.

The formula recommended is for use in traps only, and is as follows:—

Pollard	4 lbs.
Molasses (optional)	4 ozs.
Arsenate of Lead (optional)	5 ozs.
Powdered Borax	8 ozs.
Water, to make 4 gallons.	

Method of Making.—With the exception of the arsenate of lead, all the ingredients will mix readily with water. Reduce the arsenate of lead to a thin paste and stir into bulk. Stir the whole thoroughly and allow to stand for two hours. When using, keep well agitated.

Note.—In the preparation of this bait the inclusion of the molasses and arsenate of lead is optional if lever-lid tins or traps are used.

Type of Traps.—The efficiency of a fly trap is greatly improved according to its design. In the large series of experiments undertaken I found that the main use of the lure was to entice the fly to the receptacle or trap. It was soon noted that the trap made of a tin having a smooth edge captured considerably fewer flies than one having a marginal edge, such as the lever-lid tins. This is accounted for by the eagerness of the fly to get to the bait. In the case of the non-marginal edged tin, the fly will crawl down the side to the lure, and there take its fill, or it may by the action of the wind or some other factor be frightened away. When a marginal-edged or lever-lid tin is employed, the fly, attracted to the bait, settles on the edge, and instead of going down the darkened sides to the lure, flies direct from the edge into the lure and is there drowned.

Therefore, in using any lure, it is advisable, if wishing for the highest results, to use 10 or 20 ounce lever-lid tins or traps having a marginal edge, deep dark traps being useless.

To preserve the traps from rusting it is essential to paint them white, inside and out. If covered traps are used, it is necessary to see that the portion of the vessel containing the bait is not darkened, or the fruit-fly will not enter.

Traps, before having bait renewed, should be well cleaned out, no trace of the old bait being left.

From April to October hang the traps in the sun half-way up the tree, in proximity to the fruit.

From October to April hang in the shade.

As before stated, traps have their main use from April onwards to November, when the frequent rains render foliage-baiting abortive. When we realise that a single female fruit-fly is capable of laying up to 300 eggs, the advantage of destroying the over-wintering fly is obvious.

The reduction brought about by the capture of flies in the winter and early summer is proportionately much greater than at a later period, when greater numbers may be captured owing to the presence of the insects in myriads.

Traps are also useful indicators of the presence of the fly in the orchard. When the fly is not numerous it is difficult to detect its presence until the fruit begins to ripen. If there are any flies about, some are sure to be captured in the traps, and when so discovered, if weather is suitable, the trees should be sprayed with the foliage bait.

Trapping the fly gives great satisfaction to the operator, because the results can be tabulated by a count of the flies captured.

CLEARING HEAVILY TIMBERED AREAS FOR PASTURE IN THE SOUTH-WEST.

A. B. ADAMS, Dipl. Agric.,
Agricultural Adviser, South-West.

The profitable establishment of pasture being the most important objective of the settler who proposes to take up dairying for a livelihood, it is proposed in this article to deal with the subject of establishing a pasture from the viewpoint of the man with only limited capital who wishes to develop a holding of 100 to 200 acres by his own exertions. In these circumstances it is very necessary that the work should be carried out in the most economical manner, assuring the best possible return for the outlay of both time and money.

To do the work at the lowest cost it is essential to work with, and not against, Nature, spreading the work over a large area for a number of years, rather than attempting to clear outright and grass a small area each year.

No hard and fast rule can be laid down for the treatment of each and every block, as the conditions vary considerably:—

(1) In the natural vegetation;
(2) In the present condition of that vegetation.

(1) The natural growth may be karri, redgum, jarrah, tingle-tingle, blackbutt, etc., either alone or a mixture of any of these, and the undergrowth may be heavy hazel and wattle scrub, blackboys and lighter scrub, or bracken and zamia palms.

(2) The natural vegetation may be in its virgin state, or may have been rung and since neglected, in which case it will probably be a mass of seedlings and suckers.

The methods followed will also depend on the soil, but this will have a greater influence on the varieties of seed to be sown than on the actual method of clearing.

AREAS OF HEAVY UNDERGROWTH.

Taking first the districts where there is a dense undergrowth of hazel, wattle, etc., under the big timber, which is usually karri, redgum, and jarrah alone, or in a mixture of two or three. Here it is perhaps well to mention that where only jarrah grows it is generally preferable to reserve the land for forestry purposes, it being more profitable to grow timber on this class of soil than to destroy the timber and attempt to grow crops.

The first operation is ringbarking. This may seem a slow method to those who are impatient to make a start, but it is necessary to make haste slowly, and the land will sweeten just as well with the timber killed as with the timber cleared. The best time of the year to ringbark is during late Spring and Summer, if for no other reason than because, when walking

among high scrub during the rainy months one is wet through all the time. There are, however, other reasons for ringbarking in the Summer. One is that, as a rule, the trees flower at that period and are using up their strength in making flowers and seed, and are consequently less vigorous; the trees are also less vigorous during the dry than during the wet season.

It is advisable to ring 100 acres the first year, but clumps and belts of green trees should be left for shelter, and good jarrahs should not be rung, as they will be required for posts, etc. The kind of ringing will depend on the settler's circumstances. If he has taken up a selection and is developing it in his spare time, while following another occupation, the timber may be all bark rung, *i.e.*, take off a good strip of bark without cutting into the sap. If anxious to start as early as possible, sap ring the big timber, cutting right through the sap into the wood, to kill the tops as quickly as possible, and thus fetch the bark and small limbs down. Saplings six inches and under in diameter should be rung by knocking off a strip of bark with the back of the axe; when so treated they generally do

Fig. 1.—Jarrah sapling ringbarked December, 1923, dead April, 1924. A sucker which has pushed through and subsequently died is shown against handkerchief. This indicates that the roots are dead.

Fig. 4.—A big redgum sapling ringbarked with back of axe December, 1923. Now dead into the ground, as shown by dead sucker.

not sucker at all but die first at the root. As the roots of small saplings are nearly all sapwood, they soon rot, and after a few years the top can be pushed over.

When the ringing is completed, go along the boundary lines and fall any tree leaning over the lines. This is work that often gets neglected, but can be done conveniently at this stage of development, and will save a lot of work in after years.

SCRUBBING.

In karri forest the scrub should not be cut until the bark is down, as it comes down in sheets which cover a lot of grass, if grass is sown before it falls. If scrubbing is left until the bark falls it is burnt up with the scrub. If the timber is chiefly redgum, or redgum and jarrah, the scrub may be cut as soon as the tops of the trees are dead.

Fig. 2.—Redgum sapling ringbarked December, 1922, grown over by a thread left on first ringing. Rung again December, 1923. Now dead into ground as shown by dead sucker.

Fig. 3.—Redgum sapling ringbarked December, 1922, died same summer. The roots will in all probability rot away this winter, and a running grass fire next summer will burn it up completely.

The best tool for scrubbing purposes is a heavy fern hook, it having two advantages over the usual axe-handled slasher: it is easier to use, and only needs a straight bush handle instead of an axe handle.

Should there be a big accumulation of leaves and rubbish under the scrub, the scrubbing can be done at any season of the year, as there will always be enough on the ground to carry a fire; if there is but little on the ground, the scrub should not be cut until November at the earliest, as if cut too soon the leaves fall off and the fire will not run.

It is therefore advisable, where there is a big area to scrub, to start on the heaviest first, leaving the lightest until the last.

When the undergrowth consists of blackboys and light scrub, the blackboys should be killed as soon as the ringing is finished. Tall blackboys are most easily killed by chopping; short thick ones are effectively poisoned with arsenite of soda. Chop once into the centre of the green top with a

tomahawk and pour in a little of the poison, and in a short time the poisoned ones will be dead and many of them should be in good condition to burn out by the time the timber is dead.

When chopping blackboys cut at least a foot below the rushes. If not cut sufficiently low the blackboy will not die.

In a test of chopping *versus* poisoning, both operations carried out on the one day, the rushes on the poisoned ones were brown some days before those chopped off.

To make arsenite of soda take 1 lb. of white arsenic and 2 lbs. of washing soda, add 2 gallons water, boil for 20 minutes, and make up to 4 gallons for use: or dissolve 1 lb. caustic soda in 1 gallon of water, stir until dissolved, add 1 lb. white arsenic, stir well, leave until next day, and make up to 4 gallons for use. By the addition of a little whiting to the

Fig. 5.—Heavy scrub in Karri forest.

solution when using, it will be readily seen which plants have been treated. Arsenate of soda, which may be used as a substitute, may be purchased by those who do not wish to have the trouble of preparing arsenite of soda.

Zamia palms may be killed with power kerosene—about an egg-cupful to each plant in the centre of the fronds—or by driving a sharp steel bar well into the plant. It is best to use the bar at the beginning of winter in order that the rainwater may run into the heart of the plant and cause it to rot.

NEGLECTED RINGBARKED COUNTRY.

This class of country is often worse to deal with than green forest, as in many cases there is a dense mass of seedlings or suckers. If these are sufficiently far apart, it is best to knock off a good ring of bark with the back of the axe, leave until dead, and then go through slashing down all green scrub ready for the fire. When dealing with jarrah seedlings or

suckers it will be necessary to use the blade, as the bark is too stringy to fly readily with the back of the axe. When the seedlings, etc., are too dense for this treatment, the only way is to fall all the small stuff on a face. It should be chopped down sufficiently long before firing to give the wood a chance to become thoroughly dry. Most of it will then burn up.

Fig 6.—Neglected Ringbarked Country.

Where the rainfall is less there will not be such heavy scrub. The timber will then require ringing, and the blackboys and palms, where present, will have to be destroyed. The costs will be less than the more heavily scrubbed country, but the same general principles will apply.

SUCKER BASHING.

The best time to do this is at the most convenient season when other work is not pressing. The main thing is not to knock them off until they are at least as thick as the thumb. At that size they can be knocked off with the back of the axe and the dormant buds at the base will be knocked off with the suckers. If the work is attempted too soon the suckers will break off without interfering with the buds at the base, and these will immediately throw out a fresh crop of suckers. Although it is important to leave suckers until large enough, it is just as important to bash them before they get so big that it is necessary to chop them or ringbark them over again. Suckers should never be cut off, as they will be almost certain to grow again. If the suckers are large enough they may, with advantage, be bashed when scrubbing; if too small to bash the fire should kill them.

Having got to the stage when the timber is dead and the scrub is all cut, it is necessary to fire it. It is best to fire it as near the end of summer as possible, taking the precautions required under the Bush Fires Regulations.

SOWING THE GRASS SEED.*

Generally speaking, grass seed should be sown after the burn. There is an exception to this rule, however. Hard shelled seeds, which do not germinate readily, may be sown before the burn if the scrub is not heavy. Almost 100 per cent. of Hubam, *Melilotus alba*, var. *annua*, and King Island Melilot, *M. parviflora*, are hard shelled. Of a sample of Boyd's Clover, *Lotus hispidus*, 72 per cent. of the viable seeds were hard shelled, and probably there is even a larger percentage in the seed of *Lotus Angustissimus*, locally known as Giblett's Grass or Manjimup Clover.

Fig. 7.—Heavy growth of saplings chopped and ready for a burn.

As soon as possible after the burn, sow the grass seed on the ashes and manure with superphosphate at the rate of about 200 lbs. per acre.

Do not attempt to clean up logs, etc., before getting the seed on, as the important thing is to get the grass started as early as possible, not out of season, of course, but with the first good rains, as the warmth of the ground and the fertiliser will ensure a good growth.

It must be remembered that this method of sowing the seed applies to conditions where the ground is soft, and there is a good bed of ashes

*See also "Pastures in the South-West," page 30, "Agricultural Journal," April, 1924.

on the surface. Where the ground is hard, and there is but little ash, it will be found advisable to clear sufficiently to be able to run a disc or heavy-tined harrow over the seed, as the majority of grass seeds are likely to grow better if buried to a depth of quarter to half an inch.

Having finished sowing the seed and fertiliser, fence in the piece that has been sown, but do not fence in a lot of scrub land with it. If a big area has been sown, put up subdivision fences.

It may be remarked here that for fences under standing timber it is better to staple the wires rather than to run them through holes bored in the posts. In the former case, if a limb falls across the fence it will only knock out a few staples; in the latter, in all probability, a number of wires will be broken.

The land having been fenced, stock can be kept off until the grass has got a good start, and when stock are turned in they will eat a good deal of any seedling scrub that comes up with the grass. As a rule, if there is only a small amount of scrub and plenty of grass, stock will keep the scrub from increasing, but, if the conditions are reversed, the scrub will invade the grass and gradually smother it.

The management with stock will depend a great deal on whether it is dry land or swamp land. If the former, it is advisable to stock lightly the first season so that the grasses, which should be chiefly annuals, may have an opportunity to seed freely and to make enough growth to carry a fire. By running a fire through the grass at the end of the first season any seedling scrub will be destroyed. The seeds of most of our scrubs require a fire to germinate them, and if a fire can be run through before the scrub has flowered, there will be but little trouble with scrub in succeeding seasons.

If the soil is wet and inclined to be swampy, the native scrubs will probably grow up again from the roots after the fire. Perennial grasses will be best for this class of soil. Fertilising and treading with stock will assist to weaken the scrub by changing the conditions. It has been found that many native plants die when the conditions are changed.

Should the ground be on the wet side most of the year, and yet so dry towards the end of summer that most of the grass is dry, it will be profitable to brush down any green scrub and run a fire over it. Scrub that grows again from the roots, and is even more vigorous after one fire, will not stand a fire two or three years in succession.

The after management of country will consist in stacking fallen limbs and logs ready to burn off when convenient. It is never advisable to make big heaps of timber for burning. A light fire does good, but if it is too hot it burns the humus out of the soil.

After the first season the grass should be top-dressed with at least one cwt. of superphosphate per acre, dry land in the Autumn, swamp in the Spring.

It will also be necessary to keep down scrub and seedling timber trees, but by judicious management with stock, undergrowth should not get out of hand.

SHEEP NOTES.

H. McCallum,
Sheep and Wool Expert.

SELECTING GOOD RAMS.

During the next few months sheep farmers will be considering—and making their annual purchases of rams. The first essential in building up a flock of sheep with good constitutions is to secure good rams, and frequently an otherwise good flock has been ruined by selecting unsuitable animals. The rams selected should be equal or superior to the ewes, and should be particularly strong in those characteristics which are lacking in the flock. The outstanding features of a good ram are masculinity, bold appearance, and thick well-shaped horns set not too close to the head (a flat-horned ram should be carefully avoided). He should possess a large frame with a good, straight back, wide well sprung ribs, and plenty of width across the shoulders, a deep girth, thus giving the heart and lungs sufficient room. The chest should be deep and wide, and the big-boned animal is preferable to the thin-boned one. The legs should be straight. Cow-hocked or knock-kneed rams are suffering from hereditary faults, and will certainly transmit these faults to their progeny. They are also usually bad walkers. The face should be open, with a good width, free from wool between the eyes. Woolly-faced rams are the cause of much work and trouble, through transmitting the defect to the flock, and they should never be purchased notwithstanding any other good points they might possess. The teeth in the bottom jaw should fit nicely on the point of the pad of the top jaw, a bad defect in sheep being an overshot or an undershot jaw, as the animal possessing either cannot feed properly. This also is an hereditary fault.

A desirable ram has a large frame, plain-bodied, and free from wrinkles on the body; and growing a big fleece of combing wool, which is of good quality, good length and density, and of bright colour without showing too much yolk. A ram covered with body wrinkles, and growing a short stapled black-tipped and heavy-conditioned wool is one which should be avoided.

The shoulder wool should be examined first and taken as a standard, and that on the remaining portion of the body should show very little variation. If the wool falls off in length and density about the extremities and belly, the ram is an undesirable animal for breeding purposes.

A good plan for the farmer who is building up his flock is to purchase his rams from reputable breeders. Oftentimes the saving of a few pounds at this stage leads to considerable loss a few years later.

Another important point is to purchase only rams of the same type as the flock, otherwise improvement in the flock is retarded and perhaps prevented. *Type can only be fixed by selection.*

The object of every sheep farmer is to obtain the greatest return from his flock, but the best results cannot be obtained where insufficient feed for the flock is provided during the summer and early autumn months. To do

this it is necessary for the farmer to have a reserve supply either in hay, oats, chaff, or some other suitable fodders. These reserves are an absolute necessity on a sheep farm, because if the ewes are allowed to fall into poor condition prior to lambing the lambs are correspondingly weak and feeble, and it is impossible to estimate the losses that occur from this cause. To-day sheep are valuable on account of the high prices that are being realised in the wool market, and when it is considered that in Western Australia fodder crops of almost every kind can be grown prolifically for the purpose of creating reserves of feed to carry the flocks over the dry seasons of the year, it is a matter of vital importance to the industry to take the necessary precautions in this direction. Sheep losses should certainly not occur, and on the other hand, with proper provision, our supplies of wool and mutton will increase by leaps and bounds.

WOOL EXPORTS FROM WESTERN AUSTRALIA.

The Quarterly Statistical Abstract for the quarter ending March 31, recently issued by the Government Statistician, contains some interesting particulars concerning the export of wool from this State. For the year 1923 the total quantity of greasy wool exported was 39,272,453lbs., value £2,993,029, while for the nine months ended March 31, 1924, the figures were 38,363,407lbs., value £3,660,143. Scoured wool exported in 1923 reached a total of 2,650,590 lbs., value £239,567, and the totals for 1924 up to the end of March were 1,210,958lbs., value £173,476. The great bulk of this wool was of course exported overseas, but the comparative figures are given as follows:—1923—Overseas: greasy 37,871,001lbs., value £2,916,955; scoured 2,624,027lbs., value £236,879. Interstate: greasy 1,401,452lbs., value £76,074; scoured 26,563lbs., value £2,688. 1924, nine months ended March 31:—Overseas: greasy 37,687,427lbs., value £3,617,428; scoured 1,190,829lbs., value £171,673. Interstate: greasy 675,980lbs., value £42,715; scoured 20,129lbs., value £1,803.

The Journal of Agriculture

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ANTS AS A DOMESTIC PEST.

J. Clark.

Department of Agriculture.

Amongst the aggravating pests which seem to take a keen delight in annoying mankind very few succeed better than ants in making life a misery when they have established themselves in, or near, the home.

Several groups of ants may well be regarded as domestic insects, since they take up their abode close to, if not in, the house; a few cosmopolitan species even follow man to various parts of the world, being transported in merchandise and food stuffs. These generally live on the food found lying about the house and in the pantry. Some construct their nests in the garden or lawn, and besides making the place appear unsightly have a habit of stinging when one is sitting about on the grass. Many of these garden ants, however, feed on other insects, so that they cannot all be looked upon as pests, even if they do make one move on at times.

One group of ants usually build their nests in the house, under the floor or in the walls, sometimes even in the furniture; these are small ants, generally known as Singapore ants, and well known all over Australia.

Many people have the idea that this and all other ants are blind, but such is not the case; there are a few groups of blind ants, but these are rarely seen, owing to their retiring habits. Most ants have well developed compound eyes placed on the sides of the head, and many have, in addition to these, three small ocelli, or simple eyes, in the middle of the head just above the large eyes. Their sight is very keen for such small insects.

The Singapore ants belong to the genus *Monomorium*. They are all small ants, and are found throughout the world. More than twenty species are found in Australia, but all the important house pests of this genus are cosmopolitan species which have been transported from other countries in ships, and in a warm country like Australia quickly become acclimatised and spread with rapidity. Owing to their small size they are easily over-looked until they become numerous. The following are the species most frequently found in the houses in this State:—

Monomorium destructor, "the yellow house ant," a cosmopolitan species whose native home appears to be India. It is the commonest species from Perth northwards along the coast, and extends as far inland as Mount Magnet. This is a very small yellowish ant, with the tip of the abdomen brown, the smallest specimens measuring less than an eighth of an inch, and the largest scarcely twice as long. The female, or queen, is fully a quarter of an inch long. The workers bite severely. This ant takes up its abode in the floor or walls of houses, and feeds on all sorts of food, but is particularly fond of cold meat left in the pantry, and may be found on old bones thrown in the back yard.

Monomorium pharaonis, "the red house ant," a tiny cosmopolitan species widely spread throughout the world, was introduced into Australia at an early date and is now thoroughly established. It is about an eighth of an inch long, though the female is twice that size. The head and front of the body are reddish, the tip of the abdomen black, with the base yellow. It feeds on

all sorts of food stuffs, and often destroys the seeds of plants. This species gets all over the furniture and beds, and it bites and stings very sharply.

Monomorium gracillima, another cosmopolitan species, which is larger and darker than the last, but is just as great a pest, and has similar habits.

Monomorium ilia, a native species, is numerous in the bush, where it lives in large colonies under stones and logs, feeding on insects and other animal food, also on the seeds of plants. If a camp is pitched near one of their nests the ants soon find the tucker box, and are as persistent as the imported species. It is a rather pretty little ant, the head and front of the body being yellow and the abdomen bright clear red, and it is slightly over an eighth of an inch in length. The species has lately been found in Queensland.

Various methods may be used to destroy or drive the ants from the house, but it must be borne in mind that the success of any method or substance depends almost entirely on the persistence and perseverance with which it is applied.

Where the nests can be located, boiling water, kerosene or benzine poured into them will destroy the ants, but where the nests cannot be found it is well to leave baits lying about so that the ants can find them. Baits may be of three forms—honey (or sugar), meat, or poisoned honey. To use the baits a few small sponges should be soaked in diluted honey or sugar-sweetened water, and in a short time the ants will swarm all over and into the sponges, feeding on the bait. These are examined at intervals and dropped into very hot water to destroy the ants, but the method must be persevered with until the trouble ceases. At times it will be found that the ants prefer meat to honey, in which cases a few bones with a little meat attached are used in place of the sponges, or any meat extract could be used with the sponges if desired, though the bones give the best results. These, as with the honey sponges, must be dropped into hot water to destroy the ants. This method will in time destroy the colony if there is no fertile queen in the nest, and no more trouble will be experienced, but if, as is generally the case, a fertile queen is contained in the nest she will continue to lay her eggs and rear the young ants, so that the whole process will have to be repeated in a few months' time. The most effective remedy is the use of poison baits, of which there are several. One giving good results is made as follows:—Sugar, 1lb.; honey, ¼lb.; water, 1 quart; arsenate of soda, ¼lb. The mixture should be boiled, and when cool used with sponges as previously described. The ants take the poisoned honey to the nest to feed the queen and young ants, which are also destroyed with the others, thus completely clearing the nest. This substance is very poisonous, and must be guarded from children and animals; the vessel containing the mixture should also be labelled "Poison."

Fumigation with bisulphide of carbon is most effective where it can be applied, but great care must be taken as the substance is highly inflammable.

When dealing with the distruction of ants it is well to remember that they only exist where they can get food, and the custom of leaving food or scraps lying about encourages them to come around.

The honey, or meat bait, is not always effective when not saturated with poison, and it should be always remembered that too much care cannot be taken when dealing with poison baits.

SURFACE DRAINAGE WITH THE "MARTIN DITCHER."

A. R. C. Clifton,
Officer in Charge of Irrigation.

The successful development of the heavier class of soil of the coastal plains along the foot of the Darling Ranges is entirely dependent upon the removal of the excess water during the winter months. The rainfall is between 35 and 45 inches per annum, and 85 per cent. of this falls between May and October, while 54 per cent. of the total precipitation is accounted

Fig. 1.—The Drain Site Ploughed.

for during June, July, and August. This class of soil is unable to absorb the rainfall and, on top of this, receives a tremendous amount of surface water from the hills. The prevention and removal of this is as important and necessary an operation in bringing this land into productivity as is

clearing and cultivation as, without its removal, only poor results could be obtained no matter what fertilisers were used.

There are some hundreds of acres of this class of country on the Perrin Estate, and portion of this was included in the Brunswick State Farm. In 1911 Professor Lowrie, the then Director of Agriculture, requested the Engineer for Agricultural Areas to lay out a system of surface drainage on this area, bearing in mind the probability that the land was not capable of carrying a large capital expenditure and, therefore, the scheme must be cheap.

The whole area was surveyed and a contour plan furnished showing the most desirable direction in which to plough in order to obtain the best run-off. Drains were cut with a road-forming machine to convey the water along the

Fig. 2.—The Martin Ditcher cutting a drain.

depressions. This work proved satisfactory so far as it went, but many clay pans were not affected; also the lands were in many instances too long and wide, and not sufficiently crowned up. In succeeding seasons these conditions were gradually improved. The furrows were shortened by putting in more drains, and the lands raised by throwing up to the same crowns for two successive seasons. However, the road-forming machine is not within the means of the average settler in the South-West, and has been found to be unwieldly in small paddocks.

During the war Mr. J. Duce brought under the notice of the writer a ditching machine which he had purchased and which was doing satisfactory work on his farm at Boyanup. A demonstration was arranged to take place during the dry period of the year, and although the land was so hard that it was necessary to break it with a dam-sinking plough, the ditching machine cut a "V" shaped drain two feet deep with a side slope of 1 to 1 with two men and four horses, the total cost of the drain being 5/6d. per chain.

The machine is called a "Martin Ditcher and Grader," and is made in four sizes, weighing from 300 lbs. to 425 lbs., and costing from £20 to £35 according to size. It is an improvement on the old-fashioned scooper, and is simply and strongly constructed of steel, consisting of a land side 30½ ft. long to which is attached an adjustable cutting blade, which on the smaller machines is 6 ft. long and on the larger ones 7 ft. It will cut drains from 3 to 4 ft. deep, and from two to four horses are required to work it, according

Fig. 3.—The Completed Drain.

ing to size and the condition of the soil. For transport it folds up flat and can be carried in a spring cart. A great thing in its favour is that there is nothing to break if large roots and stumps are encountered, but of course it is necessary to remove these. As a commencement a furrow is made with a plough and the machine placed in this; it then does its own ploughing and throws out the dirt as it goes. As it is reversible the spoil can either be thrown on one or both sides of the drain. It will cut small roots and shrubs, and is excellent for cleaning out and keeping in repair existing drains.

After noting the good work carried out by this machine under unfavourable conditions, exhaustive inquiries were made from the manufacturer and it was decided to endeavour to secure one, but none were available in the Commonwealth and it was impossible to import during the War. An order was, however, placed with the State Implement Works, and two or three machines were made. These were chiefly used in connection with work being conducted by the Albany Land Development Committee, but as these machines were protected by patent rights, it was impossible to manufacture them for sale. The imported machines are, however, now procurable and are doing good work in the country.

Fig. 4.—The First Breaking-up, showing furrows running in direction of the Fall.

With the object of reducing the cost of draining, assisting the "small man," and at the same time demonstrating that draining is within the means of the average farmer, the Department has purchased three of these implements for the purpose of loaning them to settlers, the only charge being the railway freight.

These machines will not work effectively in the clayey land during the winter, as it becomes too sticky and clogs the blade; also, under these circumstances the country is, as a rule, too slippery for the horses to get a foothold. In the summer this land becomes too dry and hard and there is, therefore, only a short period in the spring and autumn when it is workable. To endeavour to get over the difficulty experiments were conducted at Bureup in April of this year with the object of trying the machine on fallow. The drain sites were ploughed in the spring and cultivated to retain the moisture in the subsoil, as shown in Fig. 1—this is typical of the heavier type of the country under discussion, in its virgin state. In July and August of every year this land is covered to a depth of half an inch or more with water which is slowly making Westward toward the coast. In this con-

dition the land is practically worthless. Fig. 2 shows the ditcher cutting the drain, in April, after six months of the driest summer on record, practically no rain having fallen during this period. If this land had not been fallowed it would have been unworkable. Fig. 3 shows a completed drain 15 inches deep and 3 feet wide at the top. This was made in four trips by two men and four horses, one mile being excavated in eight hours. Fig. 4 shows the first breaking up (note the narrow, well-crowned lands and the furrows running in the direction of the fall). Under these conditions this land, when worked and sown with Subterranean Clover, should produce a tremendous amount of feed. After a few years it should be in a fit state to carry the cost of total clearing and more complete draining for cropping, not only in the winter but also in the summer when, by thorough cultivation, crops could also be grown.

In my opinion it would be a profitable investment if every Road Board were equipped with one or two of these ditchers as, apart from their usefulness for making and keeping in repair drains, they are also useful for road forming. For this purpose a special blade can be obtained, and when not working on the roads these machines could be hired out to settlers in the district, so that they would become a source of revenue to the Road Board as well as being a great help to the farmer.

It is believed that similar good work can be done with this ditcher in the wetter portions of the agricultural areas served by the Great Southern Railway, and an endeavour will be made this season to conduct Farmers' Trials in this district to demonstrate this.

In every drainage proposition the first necessity is to determine the fall of the land. To do this it is always advisable to have levels taken, and a contour plan of the area mapped out. The Department has Field Officers who are continually in the country doing this work.

A rough contour plan is invaluable to a settler taking up a new area in the South-West, as it enables him to place his fences in the most suitable position from a drainage point of view, it being always advisable, where open drains are used, to have them against the fences, but it is not always possible to do this if the fences have been erected without taking into consideration the positions of probable drains.

After seeing a contour plan, the next operation should be the construction of an intercepting drain along the high side of the area to be cultivated. The deeper this is made the more effective it will be, and it certainly should be deep enough to penetrate to the subsoil as it will then not only intercept surface drainage and divert it round the area, but will also pick up water travelling underneath the surface. "Prevention is better than cure," and if outside drainage water can be cut off, only the actual rain falling on the area is left to be dealt with. The simplest way of doing this is to plough into "lands" of not more than three to the chain, or approximately seven yards in width, with the water furrows running in the direction of the fall. Every 10 chains, more or less, according to the fall and contour, intercepting drains should be constructed across the ploughing, to carry off the water, as it is not advisable to have the water furrows any longer. A drain should also be provided along the lowest portion of the field for the furrows to empty into and to carry the water away.

The general facts on drainage are known to most progressive farmers, and it is not my intention to elaborate here on the theory of drainage but rather to show how land can be made more productive by following simple methods and using an effective machine.

THE ROYAL CHAMPION CROP COMPETITION, 1924-25.

The Royal Agricultural Society, with the assistance of the Hon. Minister for Agriculture (Hon. M. F. Troy), is offering, in three different zones, Champion Prizes of £15 and Reserve Champion £5 for the best plot of wheat, of the one variety, of not less than 50 acres (which must be clearly defined), to be judged according to the following scale of points:—

(a) Estimated yield, having regard to the average yield for the district in which the farm is located		35 points.
(b) Freedom from weeds		25 points.
With penalties as follows:		
New land	6 points	
Second crop	4 points	
Third crop	2 points	
(c) Freedom from admixture		15 points.
(d) Evenness of growth		10 points.
(e) Freedom from disease, smut, takeall, etc.		15 points.
		100 points.

The exhibitor must arrange for Judge to be met on arrival of train, conveyed to plot of wheat, *and returned.*

The Judge's report will be available for publication.

One bag of wheat from each competing crop must be exhibited at the 1925 Royal Show, with the following details:—

(a) Name of variety and area planted.
(b) Method of cultivation.
(c) Quantity of seed per acre.
(d) Kind of fertiliser and rate per acre.
(e) Yield per acre.
(f) Rainfall during growth.

Competitors being first or second prize winners in District Competitions enter without fee, but where Societies in any zone are not holding Crop Competitions competitors from that zone may enter through the Royal Agricultural Society on payment of any entry fee of 5s., in which case these crops will only compete for champion prizes in their respective zones.

No exhibitor is entitled to make more than one entry, nor shall more than one entry be received from the same farm.

Entries close 1st September with W. J. Ashton, Secretary, at 7 Queen's Hall, Perth.

THE PLAGUE LOCUST.

By L. J. Newman,

Entomologist, Department of Agriculture.

Chortoicetes Terminifera (Walker).

This group of insects belongs to the order *Orthoptera* and to the family *Acrididae*. All the members of the family are vegetable feeders, and hence must be considered harmful from the agricultural standpoint. All hot or temperate countries of any extent containing areas of dry or semi-arid lands and where the climate is subject to varying conditions of rainfall, has its locust troubles. Perhaps of all insect pests locusts in swarms are most to be dreaded because of their method of attack in massed formation and the rapidity with which they will lay waste a crop which is just about to yield a reward to the grower. Other insects may do an equal amount of damage during the year, but it is more gradual and is not done whilst we look on, so to speak.

A locust is a grasshopper, which has developed different habits. For instance, grasshoppers lay their eggs on foliage, appear in pairs, never assume the gregarious or massed formation, and do not migrate long distances. The locust lays its eggs in the ground, assumes the gregarious or plague formation, and in some instances travels or migrates long distances. It usually frequents or has its permanent breeding grounds in open, plain country, with light rainfall.

With the growth of agriculture in recent years, we have pushed our settlements Northward and Eastward into districts which, a few years ago, were considered of little use from an agricultural point of view, and in so doing, we have encroached upon the preserves of the locust, and have opened the way for locust invasion. The clearing of the timber and scrub belts has reduced the insectivorous bird life which under natural conditions acted as a check or barrier, and confined the pest more or less to given areas. By ring barking large areas of timber years before the land has been cultivated we have created open ungrassed country which makes ideal laying grounds for the locust. It has been noted, particularly in the Morrell lands, that the country does not produce grass until it has been broken and cultivated. These conditions of open, warm, bare areas have been readily taken advantage of by the invading locusts, and instead of returning to their natural permanent breeding grounds, they have during recent years established themselves in the new artificially produced breeding grounds. Until this land is brought under the plough, a locust invasion of our newer Eastern and Northern districts is always possible. During the past four or five years these grounds have given rise to swarms of locusts, the result being that crops in close proximity have suffered serious depredations, and in some instances almost total loss. The area so far infested is limited, and by the combined efforts of the farmers concerned, the locusts may be wiped out or forced back to their original breeding places.

The locust referred to in this article is found in all the States of Australia, and has at times been responsible for very serious losses in the Eastern States. Fortunately, they do not generally appear in plague form more than two years in succession, and after reaching the maximum of breeding they may not for several years again appear in plague form. This is due to several factors—climatic, the increase of parasites, and bacteriological and fungoid diseases.

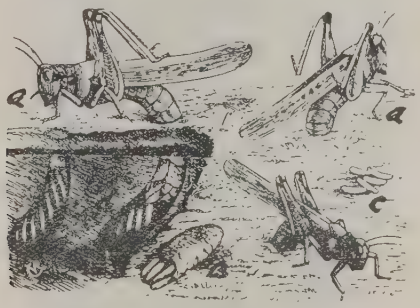
LIFE HISTORY AND HABITS.

Where the Eggs are laid.—The locust lays its eggs in almost any kind of soil so long as it is compact, hard stubble paddocks, ring-barked, ungrassed country, roadsides, sheep pads, headlands around crops, etc., being much favoured for egg deposition. Land carrying a good sward of grass, or shaded, or of a natural loose, sandy nature is avoided.

Typical ring of males as seen around egg-laying female.

Manner in which the Eggs are laid.—The female when about to lay her eggs selects a suitable location. The males form a ring around the female. This is indicative that the females are about to lay

or are actually laying. By means of the two pairs of hard, horny chitinous valves, situated on the posterior extremity of the body, she bores a hole in the soil, from one to two inches deep. These horny appliances or valves are so constructed that, when opened and shut by the muscular action of the body, they function in much the same manner as an auger. The act of forming this hole in the ground, which is termed the egg tube or egg pod, I have known take as long as three to four hours, but the nature and texture of the soil, combined with the warmth of the day, largely govern the time necessary for the operation. The finished tube is found to be generally slightly curved and always more or less oblique. When the boring and egg-laying is in operation,



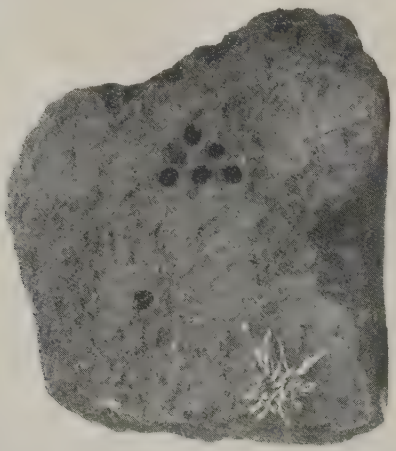
Female locust in act of laying. *a, a, a,* female in different positions, ovipositing; *b,* egg-pod extracted from ground, with the end broken open; *c,* a few eggs lying loose on the ground; *d, e* show the earth partially removed, to illustrate an egg mass already in place and one being placed; *f* shows where such a mass has been covered up. (After Riley.)

it is noted that from the tip of the abdomen is exuded a white, frothy fluid which, being of a sebific or oily nature, lines and caps the tube with an impervious covering, thus protecting the eggs against predaceous insects, excessive moisture, etc. An examination of many such tubes revealed that the parent locust had carefully packed on an average 25 to 30 eggs. The eggs are so arranged that, upon hatching, the young hoppers are enabled to escape from the tube without difficulty or injury to the delicate membrane in which they are encased. The hoppers when hatching can be seen pouring out of the egg tubes one after the other through the one small hole, and when they reach the surface they are still encumbered with a delicate film. They remain quiet for a short period, apparently waiting for the drying and cracking of this film, after which they have full use of their limbs, and can readily hop about. On a calm, fine day these tiny cast skins can readily be observed around the exit hole.

Time of Hatching.—The progeny of the eggs which are laid in October-November, and which give rise to the plague swarm, issue from the second week in July to mid-August, according to the season, after having been in the group for a period of 8½ months. In the agricultural areas so far infested by this species, there is, fortunately, only one generation per annum. Further North a second swarm, during March, has been witnessed. After

resisting the hot, dry conditions of summer, the eggs do not hatch upon the advent of the warm autumn rains, but remain as eggs until after about three months of wet weather, when, as before stated, they issue in early spring.

Owing to the irregular laying period, the issue of the hoppers occurs in what might be termed relays. The main or plague swarm all issue, however, within a week or ten days. These form the main destructive army, the later relays coming on in lesser numbers and too late to affect the wheat.



Section of soil showing uncapped Locust Egg Pods from which young have issued.

Habits of the Young Hoppers.—Although possessed of remarbably active powers from the time they have shed their first skin, they do not travel any distance so long as a food supply is at hand, and, therefore, do not at first create any apprehension amongst the farmers. This is unfortunate, as this stage of the locust's existence is the most vulnerable, the tiny hoppers being readily destroyed by spraying with Arsenite of Soda, dusting with same in powdered form, or using various other contact washes. As soon, however, as the food supply becomes short, the migration in massed form begins. The locusts advance in armies, devouring weeds, grass, crops, etc., and cleaning everything up as they go. This spirit of migration seems to be developed after and not before the first moult. Up to this period, they are content to huddle together in warm places, without partaking of much food.

The locusts display the gregarious habit from the time of emergence until death. When in crops, they have a common habit of massing themselves together overnight or during cold, windy weather in the furrows made by the drill or harrows, or in other inequalities of the land. They are sun-loving insects, their general activities being governed by the weather conditions. Bright sunny days accelerate their movements and stimulate their feeding capacity.

The locust gradually goes through what is termed an incomplete metamorphosis or change of form, reaching the adult winged stage by a series of five moults. The young, on issuing from the eggs, have a direct resemblance

to their parents with the exception that they have not wings. They do not, like insects that have a complete metamorphosis, go through the stages of larva and pupa to imago, but continue active throughout their lives, except when casting their skins or moults. The colour of the young hoppers may vary from light to dark brown to almost black.

Pre-winged hopper stage.

Period of pre-winged stages.—The young issuing in mid-July are winged or full grown in mid-September, a period of two months; those hatching later, in mid-August, reach maturity in mid-October.

Adult or full-grown Locust.

The Adult or Winged Form.—The colour of the fore or front wings is a light brown, mottled and splashed with darker brown and clouded at the tips; the hind wings are transparent and clouded at the apex. The general colour of the insect is amber brown, the legs being marked with spots or bands

of chocolate brown. The hind legs are highly developed for jumping or hopping. The antennae is short, in contra-distinction to the long-threadlike antennae of the grasshoppers.

The female measurements are:—From head to tip of folded wings, about 1¼ inches; from wing tip to wing tip, 1½ to 1¾ inches. The males are always smaller. The powers of flight in both are well developed, but to date no known long distance flight, as a swarm, has been recorded in our agricultural areas. The adult winged locusts live on an average six weeks, although under cage conditions they have been kept alive for nine weeks. Egg laying takes place some three weeks after reaching maturity. They therefore have a total life cycle as follows:—

Egg stage	8½ months.
Hopper or pre-winged stage	2 „
Adult winged stage	6 weeks.
Total	12 months.

The locusts are undoubtedly most destructive in the adult stage, as, when winged, there is no controlling their movements. They can fly to all parts of a crop, which by this time is well in ear. The stem is attacked at the base of the ear, causing the head to fall, which, if not too ripe, is eaten by those on the ground. To attempt control measures at this stage is difficult and more expensive than when in the massed pre-winged period.

It is not suggested that no effort should be made to poison or destroy the winged locusts, but stress is laid on the fact that much cheaper and effective work can be accomplished while they are in the pre-winged stage.

PREVENTIVE MEASURES.

First and foremost as a preventive measure it is desirable to refrain from ring-barking forest country in the locust areas years before the land can be brought under the plough, so this ungrassed country simple becomes a breeding area for the pest. The timber in its natural state acts as a very effective barrier against the locust. All the large areas now in this condition should be cleared and broken up to grass or crop as soon as possible. Farming in proximity to such areas is risky, as the crops are sure, sooner or later, to be invaded by the locusts hatched in the breeding area. I have witnessed the total destruction of fine crops by locusts which were hatched on adjoining uncultivated properties and afterwards invaded the surrounding crops. Hard stubble paddocks are favourite egg-laying grounds. These should be fed off and broken up before July, thus destroying the eggs by exposing them to the elements, birds, predaceous insects, etc. If these preventive measures are taken much will have been done to check the swarming of this locust.

COMBATIVE MEASURES.

The farmer in the locust belt must be always prepared for an outbreak. What will happen any season no one can correctly forecast. The fact that locusts do not usually appear in plague form every year, has, unfortunately, led to much laxity on the part of many farmers who are optimistic enough to

think that the pest will not be present next season. It is not until an army of hoppers or winged swarms begin to invade their crops that any alarm is felt, and whilst the people most vitally interested exhibit this laxity it is difficult to see what can be done to mitigate the locust plague.

To be unprepared is to suffer accordingly. A farmer may know all the different means that were ever invented of destroying the insect, yet if his lands are suddenly invaded and he is not prepared, he is in no better position than his most ignorant neighbour. The loss of his crops is just as certain, and his knowledge has availed him nothing. It is a fact, perhaps but little appreciated but nevertheless true, that no field pest causes such rapid loss and for which preparedness is so essential as the locust.

The control of the pest offers many difficulties. The chief of these are the breeding grounds in such places as waste, unoccupied, poor lands, roadsides, commonages, ring-barked unbroken country, etc. Here they hatch out unmolested, later migrating into the surrounding crops and pastures. It is obvious that any attempt at control must be co-operative. Should an outbreak be reported in any portion of the district, whether on farming or unoccupied lands, it is in the interests of all parties that every effort be made to cope with the plague. It may be that an outbreak occurs some miles distant from

Tachinid Fly (parasitic on locusts).

any farm, but no one can determine the direction the hoppers or the winged adults will take in search of food requirements. The great need, therefore, is for intelligent, active interest and co-operation among the farmers. In South Africa this co-operation is by means of what is termed the "Farmer's Circle System."

A tour of the invaded districts was made and meetings called in each "Circle," which embraced a defined area of country. The elected Chairman of each Circle was also gazetted an Honorary Inspector under the Insect Pest and Plant Diseases Act. The farmers agreed (whether locusts were present or not on all farms)—(a) To assist each other in the destruction of all

locusts within the Circle; (b) To empower the Chairman of the Circle to enter any alleged defaulter's farm with a view to satisfying the Circle that the locusts were not being properly destroyed; (c) To report to the Department of Agriculture any occupier within the Circle who failed to fulfil his obligations, so that the Department could step in and destroy the locusts at the defaulter's expense, or take such other steps as seemed desirable.

It was also further agreed that each Circle purchase co-operatively the necessary ingredients for the destruction of the locusts. By buying in quantities considerably cheapened the cost.

The adoption of this system has proved most successful in several districts where it was carried out in a thorough spirit of co-operation by the farmers, thus rendering the work of destroying locusts effective by the compulsory enactment of the laws dealing with locust destruction.

During the past three years the Agricultural Department of this State, with the assistance of a number of reliable farmers, has carried out a series of field experiments, consisting of trials with contact non-poisonous and poisonous sprays and various poison baits. It is not intended to give a detailed account of these trials, but to simply quote those which proved effective and were within economic bounds.

As non-poisonous contact sprays applied to the hoppers up to the third moult, the two soaps which were found very effective were Burford's Household Carbolic soap and Sunlight soap. The former, used at the rate of 2½ ozs. to the gallon, and the latter, at the rate of 2 ozs. to the gallon, cost 1½d. per gallon. Both have to be applied hot and are most effective in the early morning when the hoppers are sluggish. Resin and soda and kerosene emulsion were used in like manner, with good results, but were more costly.

Poison Contact and Internal Poison Sprays.—It was found by experiment that these sprays were fatal, owing to their caustic action and the absorption of the poison through the skin of the insect, and also by the consumption by the insect of the foliage so sprayed causing internal poisoning. They were as cheap and more effective than the straight-out contact sprays.

The first formula tried was arsenate of soda 1lb., molasses 3lbs., water 12 gallons. This was sprayed over the young hoppers, weeds and grass. The result was the killing of myriads of the tiny hoppers. The grass and weeds were somewhat scorched, but ultimately recovered.

The second test was with arsenite of soda 1lb., molasses 3lbs., water 16 gallons. This was applied in the same manner as the arsenate of soda. The results were much the same, a slightly better poisoning effect being observed where the arsenite of soda was used.

Tests of both these poison sprays were made on crops with about 18 inches of growth, into which the hoppers had advanced. It was found that although very effective in destroying the hoppers, the flag or leaf of the wheat was very much scorched. The season being somewhat dry, the portion of the crop so treated never really recovered. Efforts should, therefore, be made to destroy the locusts before they enter the crops. In actual practice it is advisable to slightly increase the strength of the poison after the second moult.

The tests were carried out with a pump mounted on a cart and two lengths of 20ft. hosing with rods and nozzles, thus permitting a strip of 40ft. wide being sprayed. The spray should be applied under high pressure, thus ensuring a fine mist. The cost of treatment of the sprayed crop was 8s. per acre.

Where grass or weeds have been so treated, it is necessary to keep stock from such areas for 12 to 14 days.

As a result of further tests which have recently been made in South Africa, it has been stated that it is not essential to include the molasses in the poison sprays, and that the use of arsenite of soda in a powdered or dust form gave equally good results as when in solution. It is the intention of the State Department to test both these claims.

Poison Baits.—Many forms of baits were used, including poisoned green stuff, horse manure and bran. The bait giving the best results was as follows: —Bran 30lbs., Paris green 1lb., molasses 5lbs. Mix the bran and Paris green together thoroughly in dry form. Reduce the molasses to the consistency of water by heating, add it to the bran and Paris green, and stir until the whole is of the consistency of stiff dough.

In the many trials made it was found that the best results were obtained by distributing the bait early in the morning. The locusts are then massed together and have fasted all night. They are naturally hungry, and when invigorated by the warmth of the sun readily partake of the baits. Millions were so poisoned during last year's campaign.

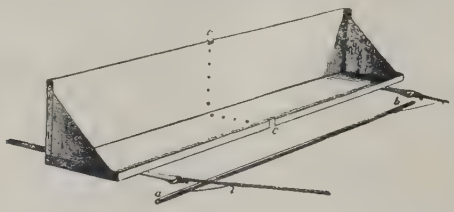
White arsenic was tried, using the same strength, but the results although good decidedly favoured the use of Paris green.

Arsenite of soda ½lb., molasses 5lbs., water 4 gallons, adding sufficient bran to make a stiff dough, was tested and proved a very effective bait. Further tests are, however, to be made. The cost of those baits averaged 8s. per acre.

The tests proved that the important point is to have a moist bait in readiness for the locusts when they commence feeding in the morning. The baiting or spraying should, therefore, be done before 10 a.m. Up till this time the locusts are in masses, later they become more active and separated, consequently the application of the bait or spray is made more difficult and costly.

Ditching or Trenching.—This method may be successfully used against an advancing swarm of hoppers, but is no use when they have attained the wing stage. The trench should be 18 inches deep by 18 inches wide. The sides must be perpendicular, so that when the young locusts stumble into them they cannot readily get out. The efficacy of the trench depends not so much on the inability of the young locust to jump it as on their tendency not to do so. Once in the trench they soon become demoralised, crippled and enfeebled by constant effort and the trampling and crowding upon one another. A deep, sharp, well-cut plough furrow around a crop into which hoppers are advancing will act as a temporary check whilst they are very small, particularly if poisoned bait is distributed therein.

Rolling.—When country is level and free of trees, stumps, etc., many locusts may be destroyed by rolling, especially if done in the early morning while they are sluggish and huddled together.



"Hopperdozer." A simple coal-oil pan, to be drawn by horse. (After Riley.)

Encouragement of Natural Enemies.—Little can be done to increase the insect enemies of the locusts, but insectivorous birds should be protected against wanton destruction by sportsmen and others.

Summary.

1. Bring into cultivation all cultivable non-grassy and ring-barked country.
2. Feed off and cultivate all hard stubble before July.
3. Locate the egg-laying grounds, plough up and expose eggs to elements, birds, etc.
4. Spray young hoppers with contact sprays in early morning.
5. Apply poison baits in early morning.
6. Dig or plough trench in advance of hoppers to protect crop.
7. Rolling to be done only on level land in early spring.
8. Encourage and protect the insectivorous birds.
9. Make your attack on this pest co-operatively.

FRUIT FLY BULLETIN.

A revised edition of the Bulletin dealing with the Fruit Fly has been issued by the Department of Agriculture. It contains all the latest information concerning the pest, the results of recent baiting and trapping experiments, and numerous illustrations. The Bulletin may be obtained free on application.

EXPERIMENTS WITH WHEAT.

Geo. L. Sutton,
Director of Agriculture.

THE ROTATION EXPERIMENTS AT THE CHAPMAN AND MERREDIN EXPERIMENT FARMS.

Though continuous wheat growing—and particularly when alternated with a fallowing period between crops—may be economically advisable in the early development of new districts, it is important to determine what effect such systems of cropping have upon the fertility of the soil as disclosed by the crop yields. If the fertility be reduced these methods must be altered, for a sound system of agriculture can only be established permanently by the adoption of methods which prevent the depletion of soil fertility.

The particular practical problem in this connection is therefore to find for each locality a rotation or system of cropping which its climatic conditions allow, and which can be made an economic success. With the object of determining the principles underlying this practical problem, the rotation experiments at Merredin and Chapman have been laid down. These experiments comprise nineteen permanent plots laid out in accordance with the following scheme:—

ROTATION EXPERIMENTS.

Chapman and Merredin Experiment Farms.

Plot	1	Wheat continuously	Rotation I.
Plot	2	Fallow	Rotation II.
	3	Wheat	
Plot	4	Fallow	Rotation III.
	5	Fodder or Renovating Crop	
	6	Fallow	
	7	Wheat	
Plot	8	Change or Renovating Crop A	Rotation IV.
	9	Wheat	
	10	Change or Renovating Crop B	
	11	Wheat	
	12	Change or Renovating Crop C	
	13	Wheat	
Plot	14	Fallow	Rotation V.
	15	Change or Renovating Crop A	
	16	Fallow	
	17	Change or Renovating Crop B	
	18	Fallow	
	19	Change or Renovating Crop C	

The arrangement shown is that for one year. In the following year the crop at the top of each rotation is placed at the bottom, and the crops within that rotation will move upwards one place. Thus the Change Crop A in Rotation IV., which was planted in Plot 8—say rape—in 1914 would in the following year be grown in Plot 13, whilst Plot 8 would be cropped with wheat.

An important economic question in connection with wheat is whether it is necessary to grow other crops, and if so, whether or not a fallow should precede every, crop. If it should not, a further question which arises is, which crops best repay fallowing? In other words, before which crops is it

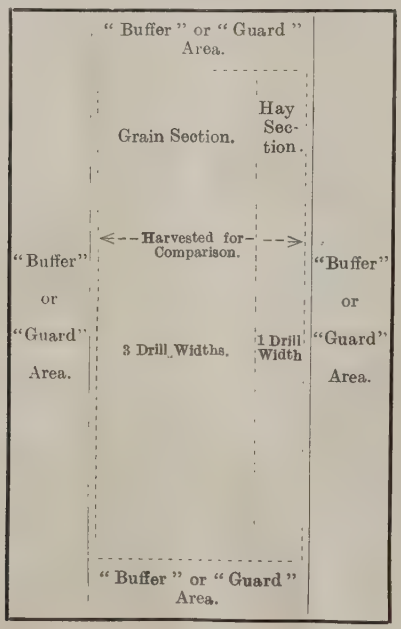
most necessary to fallow the land? These experiments have been designed to furnish information on these points. A comparison between the yields of wheat in Rotations I. and IV. with those in Rotations II. and III. will show the effect of fallowing upon the wheat crop. A comparison between the yields of wheat in Rotations I. and IV. will reveal the effect of cropping the land continuously in one case with wheat solely, in the other case with change crops. The effect of growing wheat after fallow, but with and without the intervention of a change crop, will be seen from a comparison of the yields in Rotations II. and III. The necessity or otherwise for a fallow to precede the different change crops used in this rotation will be disclosed by the results obtained with them in Rotations IV. and V.

These experiments are being carried out at the Merredin and Chapman Farms. At Merredin the block of land on which the plots were laid out is first-class forest land and typical of much of the forest land in the wheat belt. At Chapman the land chosen for this experiment is very light sandy scrub of low fertility.

Each plot is a miniature paddock, though at present unfenced. It is one chain wide and 10 chains long at Chapman, and 9.20 chains long at Merredin. The centre portion only of the plot is used for comparative purposes. This consists of an area which is as wide as is required for the seed drill in use to make four trips—at both farms equivalent to about 56 links. At harvest time the ends of the portion planted are cut off, so that the area available for purposes of comparison is half an acre. One of the drill widths (an eighth acre) is cut for hay and the remaining three drills (three-eighths acre) harvested for grain.

The arrangement of each plot is shown in the accompanying sketch.

Headland.



MERREDIN EXPERIMENT FARM.

Wheat without Fallow, 1919.
(Note same Plot in 1923.)

Wheat after Fallow, 1919.

The plots were laid down at Merredin in 1914, but owing to the unprecedented drought of that year the real start was not made until 1915, and the first results became available during the 1916 season. At Chapman the work was not undertaken until 1917.

At the Merredin Farm weeds have been troublesome on these rotation plots from the initiation of these experiments. The principal ones were Wild Oats (*Avena fatua*) and Wild Mustard (*Sisymbrium officinale*). The latter was brought under control by judicious grazing and cultivation on all plots, but the Wild Oat on the fallowed plots only. Largely because of fresh invasions of seed from the adjacent railway line the wild oat continued to increase on the unfallowed plots, until in 1921 it was so thick and such a menace to the crops on the fallowed plots that it was decided to fallow the whole of 19 plots in 1922 in order to cope with this scourge. Because of this compulsory treatment of the block, the crops of 1923 are dealt with separately from those of previous years, and the yields are not included in any averages used for comparison.

At the Chapman Farm Cape Weed (*Crytostemma calendulaceum*) and Spanish Radish (*Rhaphanus raphanistrum*) have been plentiful, but have been kept in control by constant and timely cultivation.

The rainfall from 1915 to 1923, as recorded in points (100 = 1 inch) at each farm, is as shown in the table hereunder:—

RAINFALL.

CHAPMAN EXPERIMENT FARM.

Year.	Jan.	Feb.	Mar.	Apl.	During growing period.							Nov.	Dec.	Total for Year.
					May.	June.	July.	Aug.	Sept.	Oct.	Total.			
1915 ...	74	465	18	46	183	436	620	315	221	240	2,015	...	35	2,653
1916 ...	317	38	...	...	113	388	346	273	...	233	1,353	61	...	1,769
1917 ...	...	...	301	72	186	696	811	471	377	143	2,684	...	66	3,123
1918 ...	12	131	9	74	257	501	263	317	228	101	1,667	...	10	1,903
1919 ...	...	5	...	129	49	460	578	223	52	55	1,426	90	12	1,662
1920 ...	9	...	138	9	426	396	278	545	147	38	1,830	5	...	1,991
1921 ...	...	120	94	2	749	356	219	168	257	132	1,881	19	102	2,218
1922 ...	4	30	36	113	163	142	364	144	170	22	1,005	7	21	1,216
1923 ...	22	16	45	91	144	1,250	207	181	138	68	1,988	...	10	2,176
1915–1923 = Average ...					...	...	...	...	...	...	1,761			2,079

MERREDIN EXPERIMENT FARM.

Year.	Jan.	Feb.	Mar.	Apl.	During growing period.							Nov.	Dec.	Total for Year.
					May.	June.	July.	Aug.	Sept.	Oct.	Total.			
1915 ...	284	237	45	48	207	132	241	241	110	78	1,009	...	1	1,624
1916 ...	136	3	19	60	103	213	193	151	39	109	808	46	...	1,072
1917 ...	...	8	435	57	159	280	331	195	198	138	1,301	69	32	1,902
1918 ...	32	188	34	74	161	250	143	151	89	139	933	123	1	1,385
1919 ...	3	...	82	302	17	105	233	164	43	186	748	38	9	1,182
1920 ...	32	28	187	122	138	206	166	229	92	27	858	38	...	1,265
1921 ...	77	30	18	...	332	156	119	161	116	64	948	5	77	1,155
1922 ...	...	52	153	114	162	18	361	75	50	8	674	21	57	1,071
1923 ...	41	136	27	170	131	479	123	54	125	34	946	...	249	1,569
1915–1923 = 9 years Average					...	...	...	...	...	...	914			1,247

From these records it will be seen that the rainfall at Chapman is far more liberal than at Merredin. For the period under review it is almost twice as much during the growing period, and 66 per cent. greater for the year.

All the operations in these rotation plots were carried out with the usual farm implements. On the plots capable of being fallowed the ploughing was done during the winter; the ground was cultivated during the spring and immediately before sowing; every care was taken to control weeds. On the continuous wheat plots the ploughing was done as soon after harvest as the rains would permit, after which the ground was brought to a good tilth by the cultivator. On the plots with change crops without fallow the ploughing was done when possible in the late spring or early summer after the change crop had matured or been fed off. If, owing to the absence of rain, it was impossible to plough these plots then, it was done as early as possible in the autumn.

THE CHANGE AND FODDER CROPS.

The change and fodder crops planted in these experiments at both farms until 1921 were:—Change Crop A, Rape; Change Crop B, Oats; Change Crop C, Peas.

The rape and peas were planted with the wheat drill, but with several seed tubes blocked, so that the plants were in drills 2ft. 6in. to 3ft. apart. This was done to permit of the ground between the drills being cultivated so as to destroy weeds and conserve moisture. At Merredin these crops were sown in April and at Chapman in June.

At Chapman both rape and peas grew decidedly better after a fallow than without one, but under the best conditions the growth in this light soil proved so uncertain and unsatisfactory that it was decided in 1921 to discontinue them. The Oat crop was far more satisfactory. Pending the discovery of a more suitable crop—preferably a legume—it was decided to utilise this crop

MERREDIN EXPERIMENT FARM.

Wheat without fallow, 1920.
(Note same Plot in 1923)

Wheat after Fallow, 1920.

for renovating purposes by growing and grazing it or by ploughing it in. During the past two years it has been ploughed in.

During the past season it was decided to try the Lupin as a leguminous renovating crop on Rotation IV. It was accordingly planted in Plot 9. This was sown in drills at the rate of 10lbs. per acre. Unfortunately the germination was poor, and the growth of the plants has not been good. As this crop is known to suit the climatic conditions of the district, it is intended to persevere with it, and if possible use it in Rotations IV. and V.

At Merredin the results with both Rape and Peas have been irregular. In some years the Pea crops have been poor on both fallowed and unfallowed land. In other years the results have been better, with a slight difference in favour of the fallowed crop, as in 1919, when the computed acre yields of greenstuff from portions of the plots were:—Peas after fallow, 3 tons 7 cwt.; Peas without fallow, 3 tons 4 cwt.

Weeds, and particularly "Wild Mustard" (*Sisymbrium officinale*) in the early stages of the experiment, and "Wild Oats" (*Avena fatua*) throughout its course, have seriously interfered with the success of the peas, the procumbent habit of which hinders the cultivation between the drills. The experience as a whole indicates that Peas are too uncertain and delicate for the climatic conditions of this district.

Rape (Dwarf Essex) has proved hardier and more suitable than Peas at Merredin, and in some years fair crops have been obtained on both fallowed and unfallowed land, but usually better yields are obtained after fallow. This is illustrated by the results obtained in 1918, when the computed acre yields of Green Rape were:—After fallow, 9 tons 8 cwt.; without fallow, 4 tons 17 cwt.

The germination of the small rape seed is somewhat uncertain, and in three years out of seven it was necessary to re-seed. The re-seeding was usually done towards the end of June, and was not too late for satisfactory results when the season was favourable. As one of the objects of sowing these change crops is to provide green fodder early in the autumn when such is scarce, it has failed in this respect whenever re-seeding was necessary.

In 1923, at Merredin, it was decided to use Horse Beans in lieu of Peas as a leguminous renovating crop. These beans had made satisfactory growth in a trial on another part of the farm and have the advantage of growing erect, and thus they offer no hindrance to the cultivating machinery. They grew well to a height of 2 feet 6 inches, and in Plots 5 and 17, which had been fallowed, seeded well, and were grazed by sheep after the grain harvest. On Plots 10 and 12, which had been cropped continuously either with wheat or change crop since the beginning of these experiments, and which were this year cropped with Horse Beans and Rape respectively, wild oats were much in evidence, and in consequence the crops on them were fed off prior to the grain harvest. The Rape planted on Plot 19, fallowed previously to 1922, was particularly good and free from wild oats, and it was fed off twice by sheep.

The effect of the single year's fallowing (1922) was not nearly as satisfactory with the change crops as with the continuous wheat plot, the satisfactory condition of which, after the fallow, may be seen from the illustra-

tions of the 1923 wheat plots, with and without fallow. The wheat crop had the distinct advantage of being planted later, which permitted cultivation after the germination of the wild oats had been started by the autumn rains.

The conclusions drawn from the results of these change crops are:—

(i) that both rape and peas are uncertain and unsatisfactory change crops for renovating purposes;

(ii) that the oat crop is much more reliable and can be recommended; and

(iii) that on fertile soils under a light rainfall, and on soils of low fertility under a light or liberal rainfall, the seed bed for these crops should be fallowed.

Now that there are early varieties of oats like "Burt's Early" available, which provide excellent early grazing, the need for rape as a fodder crop is not pressing. The latter, however, has the advantage that it is deep rooting, and when for this reason it is desired to plant it, the recommendation is made that it be sown mixed with an early grazing oat, say, in the proportion of Rape 11lb., Oats 20lbs. per acre. In this way, when the germination of the Rape is good, the benefits due to its deep rooting habit will be largely realised, and the risk of an entire failure of the grazing crop is lessened.

WHEAT AND OATS.

The details of the cropping and the computed acre yields of the wheat and oat crops for 1923 are as hereunder:—

ROTATION EXPERIMENTS—MERREDIN EXPERIMENT FARM.

COMPUTED YIELDS—SEASON 1923.

	Hay.			Grain.	
	cwt.	qrs.	lbs.	bus.	lbs.
1.—Wheat "Merredin"	43	0	24	25	44
2.—Wheat "Merredin"	45	0	0	28	0
3.—Fallowed					
4.—Fallowed					
5.—Horse beans (pastured after grain harvest)					
6.—Fallowed					
7.—Wheat "Merredin"	48	2	16	26	16
8.—Oats "Lachlan"	42	2	16	30	32
9.—Wheat "Merredin"	43	2	0	28	0
10.—Horse beans (fed off in spring)					
11.—Wheat "Merredin"	46	0	24	27	44
12.—Rape, Broad Essex (fed off in late spring)					
13.—Wheat "Merredin."	45	3	3	30	32
14.—Fallowed					
15.—Oats "Lachlan"	51	0	0	32	16
16.—Fallowed					
17.—Horse beans (fed off after harvest)					
18.—Fallowed					
19.—Rape (fed off twice, in spring and early summer)					

It will be seen that the above yields are very similar despite the varying treatment given the plots prior to 1922. It is surprising that one year's good fallowing should put in such good "heart" land which without fallow was not able to produce a crop worth harvesting.

The variety of wheat or oats planted in any one year has been the same on all plots. At Chapman, from 1917 to 1922, the variety of wheat was "Comeback," and from 1921 to 1923 "Nabawa." At Merredin it was "Bunyip" in 1916, "Federation" from 1917 to 1920, and "Merredin" in 1921 and 1923. The rate of seeding at both farms was approximately 45lbs. per acre, and ranged from 41 to 48 lbs.

The variety of oats used at Chapman was "Algerian" in 1917, and "Burt's Early" since that year. At Merredin the variety used was "Algerian" until 1921, after which "Lachlan" was sown. The quantity of seed used was about 35lbs. at Chapman and 30lbs. at Merredin.

The fertiliser applied was superphosphate, at the rate of 85lbs. per acre at Chapman and 70lbs. at Merredin, until 1923, when the amounts were increased to 95lbs. at Chapman and 84lbs. at Merredin.

The seed was planted during May.

The results obtained with these staple crops, computed to acre yields, are as hereunder:—

ROTATION EXPERIMENTS—CHAPMAN EXPERIMENT FARM.

Wheat and Oats—Hay Yields.

Rotation.	1918.	1919.	1920.	1921.	1922.	1923.
	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.
Wheat continuously without fallow	9 2 0	3 2 8	5 1 4	13 1 4	8 2 8	5 0 8
Wheat continuously after fallow	17 2 8	19 1 4	11 2 8	19 1 4	17 3 4	10 2 8
Wheat after fallow and after fodder crop	...	...	15 1 12	*	17 0 8	13 3 20
Wheat without fallow after change crop	14 1 22	4 0 21	4 3 23	8 1 4	11 2 24	4 0 0
Oats without fallow after change crop	13 0 24	11 3 4	5 0 24	12 2 24	13 0 0	Harvested for grain.
Oats after fallow and after change crop	16 0 8	33 0 24	9 3 12	17 3 4	16 3 12	Pastured.

* Previous crop was oats for hay.

Wheat and Oats—Grain Yields.

Rotation.	1918.	1919.	1920.	1921.	1922.	1923.
	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.
Wheat continuously without fallow	4 27	2 27	0 48	10 35	6 43	2 27
Wheat continuously after fallow	9 36	10 56	3 39	18 16	15 41	9 33
Wheat after fallow and after fodder crop ...	...	...	6 13	*	16 51	12 40
Wheat without fallow after change crop ...	8 34	3 14	3 28	10 3	9 4	4 28
Oats without fallow after change crop ...	10 0	8 32	4 19	11 29	8 37	9 16
Oats after fallow and after change crop ...	8 24	19 19	5 3	14 8	12 19	27 0

* Previous crop was oats for grain.

ROTATION EXPERIMENTS—MERREDIN EXPERIMENT FARM.

WHEAT AND OATS—HAY YIELDS.

Rotation.	1916.	1917.	1918.	1919.	1920.	1921.
	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs.	cwt. qr. lbs
Wheat continuously without fallow	10 1 2	49 3 12	29 3 4	31 0 0	27 2 8	Failure.
Wheat continuously after fallow	21 3 4	61 0 16	44 3 4	38 0 8	44 2 0	40 0 12
Wheat after fallow and fodder crop	...	63 0 20	51 0 8	46 2 16	45 2 24	41 3 20
Wheat without fallow after change crop	13 0 21	57 2 8	40 0 27	30 2 8	17 1 20	Pastured.
Oats without fallow after change crop	10 3 20	48 1 12	30 0 16	37 0 16	22 1 20	do.
Oats after fallow after change crop	28 2 16	60 0 8	63 0 12	48 2 24	57 0 8	33 1 12

WHEAT AND OATS—GRAIN YIELDS.

Rotation.	1916.	1917.	1918.	1919.	1920.	1921.
	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.	bus. lbs.
Wheat continuously without fallow	Failure.	28 0	18 43	14 8	3 50	Failure.
Wheat continuously after fallow	12 45	32 32	22 48	26 16	20 24	21 33
Wheat after fallow and after fodder crop ...	...	29 42	22 58	26 38	20 40	22 40
Wheat without fallow after change crop ...	3 25	27 40	22 5	9 47	*	Pastured
Oats without fallow after change crop ...	*Nil*	16 27	20 3	13 24	*	do.
Oats after fallow and after change crop ...	16 32	23 8	34 29	18 8	21 3	† Not available

* Owing to wild oats these plots were cut with binder whilst green to prevent shedding in 1920.

† Owing to an accident the grain yield in 1921 is not available for comparison.

AVERAGE RESULTS.

Average results have been compiled from the yearly results, excluding those at Merredin in 1923, as in that year all crops were grown after fallow in all rotations. It has not been possible in all cases to obtain average results for the full period of the experiment, but the average given is always for as lengthy a period as could be obtained, and whenever comparisons are made the averages given are for the same period, *e.g.*, the comparison made between continuous wheat after fallow and wheat and change crop after fallow

is for three years, and the comparison with the former and continuous wheat without fallow for six years. The average results so compiled are:—

AVERAGE HAY YIELDS.

WHEAT AND OATS.

	Chapman.				Merredin.			
	Period.	cwt.	qrs.	lbs.	Period.	Cwt.	qrs.	lbs.
Continuous wheat after fallow ...	1918/23	16	0	1	1916/21	41	2	26
Continuous wheat without fallow	1918/23	7	2	5	1916/21	24	3	1
Increase in favour of fallowing	...	8	1	24	...	16	3	25
Wheat without fallow after change crops	1918/23	7	3	20	1916/20	31	3	6
Continuous wheat without fallow ...	1918/23	7	2	5	1916/20	29	2	24
Increase in favour of change crop	...	0	1	15	...	2	0	10
Wheat and fodder crop after fallow	1920, 1922	15	1	23	1917/21	49	2	23
Continuous wheat after fallow ...	1923	13	1	7	1917/21	45	2	25
Increase in favour of fodder crop	...	2	0	16	...	3	3	26
Oats after fallow	1918/22	18	3	1	1916/20	51	2	2
Oats without fallow after wheat	1918/22	11	0	21	1916/20	29	3	6
Increase in favour of fallowing	...	7	2	8	...	21	2	24

AVERAGE GRAIN YIELDS.

WHEAT AND OATS.

	Chapman.			Merredin.		
	Period.	bus.	lbs.	Period.	bus.	lbs.
Continuous wheat after fallow ...	1918-23	11	17	1916-21	22	43
Continuous wheat without fallow ...	1918-23	4	35	1916-21	10	47
Increase in favour of fallowing ...	...	6	42	...	11	56
Wheat without fallow with change crops	1918-23	6	27	1916-19	15	45
Continuous wheat without fallow ...	1918-23	4	35	1916-19	15	13
Increase in favour of change crop	...	1	52	...		32
Wheat and fodder crop after fallow ...	1920, 1922	11	55	1917 21	24	32
Continuous wheat after fallow ...	1923	9	38	1917 21	24	43
Increase in favour of fodder crop	...	2	17	...		11*
Oats after fallow	1918-23	14	19	1916-19	23	9
Oats without fallow after wheat ...	1918-23	8	36	1916-19	12	24
Increase in favour of fallowing ...	...	5	23	...	10	25

* Decrease.

A better realisation of the relative differences between these average results is obtained when they are all expressed as percentages of the yield of the plot cropped with continuous wheat without fallow. In table hereunder this has been done, the yield of the plot referred to being expressed as 100.

ROTATION EXPERIMENTS—CHAPMAN AND MERREDIN EXPERIMENT FARMS.

PERCENTAGE YIELDS.

WHEAT AND OATS.

	Hay.		Grain.	
	Chapman.	Merredin.	Chapman.	Merredin.
Wheat without fallow	100	100	100	100
Wheat without fallow after change crop	105	107	141	104
Wheat after fallow	212	169	246	211
Wheat after fallow and fodder crop ...	246	184	304	209
Oats without fallow	100	100	100	100
Oats after fallow	168	173	163	184

CONCLUSIONS AND RECOMMENDATIONS.

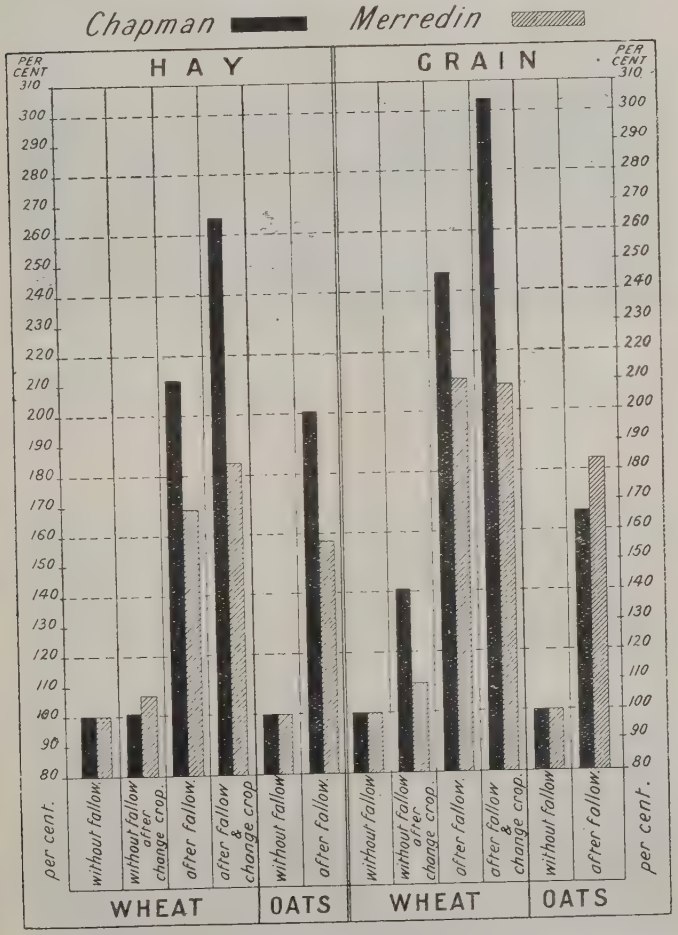
The striking feature brought out by the cold evidence of the recorded yields of both hay and grain, with both wheat and oats, and at both farms, is the great proportionate increase which has resulted from the operation of fallowing in connection with the preparation of the seed bed. This is strikingly illustrated by the graph on page 221. The increase is very definite, and the acreage ranges from 68 per cent. with oats for hay after fallow, at Chapman, to 204 per cent. with wheat for grain after fallow and a renovating change or fodder crop at Chapman. In every case the yield after fallow was greater than without.

That the largest proportionate increase in yield should be at Chapman, with the rainfall almost twice as great during the growing period as at Merredin, will come somewhat as a surprise to those who possess only the generally accepted view with regard to fallowing, viz., that it is beneficial because of the moisture which is conserved from the previous winter for the use of the succeeding crop. This, however, is not the only result obtained by fallowing. Professor Paterson in 1912, by experiments carried out at Geelong, Victoria, showed that in Australia, as elsewhere, in well-worked fallowed land nitrates were produced and stored in the soil during the summer for the use of the succeeding crop.

With the liberal rainfall which occurs at Chapman, it is very doubtful whether fallowing is necessary for the conservation of moisture at that farm. By the good results obtained it has proved, however, to be warranted on the light soil, and for this reason it is considered that the beneficial effects of fallowing at this farm are mainly due to the increased production of nitrates

resulting therefrom. The land on which the experiments were conducted at Chapman is of low fertility, and in view of the liberal rainfall there and the results obtained with a much lighter rainfall at Merredin on better soil, it is obvious from the yields obtained that the plants on the unfallowed plots were actually starving for nitrates.

ROTATION EXPERIMENTS AT CHAPMAN AND MERREDIN FARMS: AVERAGE PERCENTAGE RESULTS.



Just as the figures recording the yields show conclusively the beneficial effect that fallowing has upon the crop yields, so observation in no less certain way shows how effective the same practice is in controlling weed growth

MERREDIN EXPERIMENT FARM.

Wheat without Fallow, 1919-1920. After Fallow 1923. Cleaned by fallow in 1922, though foul with weeds in 1921, as illustrated in 1919-1920. Now as clean as adjoining plot in 1923, shown below.

Wheat after Fallow, 1923.

at both farms. This feature is shown in the illustrations herewith which depict the weedy character of the plots cropped continuously without fallow, and the adjacent fallowed plots in 1919 and 1920. In 1920 the fallowed plot was contiguous to the unfallowed, and in 1919 only one chain distant. In 1921 the unfallowed plot was so overrun with wild oats that it was not worth harvesting, and in order to reduce the pest this plot, with all the other plots, was fallowed. The effect of fallowing this very weedy plot for one year is seen from the illustration depicting it as it appeared in 1923. It will be seen that the crop in that year is practically as free from weeds as the adjacent plot, and which had been previously fallowed throughout the course of the experiment.

The effect of introducing a change crop for renovating purposes is not nearly so marked as the direct effect of fallowing. At Merredin, except with hay after fallow, it is practically negligible. The results on the unfallowed plots show a slight increase of four and seven per cent., but this is too small to be significant, and may be due to the earlier preparation which it was possible to give the seed bed of these acre plots. It was sometimes possible to prepare these in late spring or early summer, and in consequence they had the advantages accruing from a late fallow. This was a benefit which could not be given to the plot cropped continuously with wheat, for at the earliest this could not be ploughed until late summer after the grain had been harvested. In Rotation III. the hay yield after fallow is increased by 15 per cent., whilst the grain yield is practically the same as fallow without fodder crop. It would appear from this that the quantity of moisture available as the plant approached maturity was not sufficient to make use of the additional nitrates which it is expected were produced as the result of ploughing in change crops or their residues. In this connection it may be stated that with a deficient supply of moisture as the plant approaches maturity an abundant supply of nitrates in the early stages of the crop, though causing an increased hay yield, would be likely to depress that of the grain.

The results so far indicate that on the fertile forest land under a light rainfall, as at Merredin, there is no special need to introduce a change crop in the rotation.

With one exception there was, at Chapman, a distinct increase in yield as the result of introducing a change renovating crop into the rotation. Though this is in contrast to the effect obtained at Merredin, it is not surprising, for with a soil of lower fertility and deficient in humus, the effect of increasing the quantity of this latter constituent would obviously have a more noticeable effect than at Merredin, where there was originally better material to work upon, and where also the results would be effected by a less liberal rainfall.

Compared with continuous wheat without fallow, the proportionate improvement consequent upon the inclusion of a change or fodder crop was:—Crop without fallow—Grain 41 per cent., Hay 5 per cent.; and with fallow—Grain 204 per cent., and Hay 146 per cent. These last two increases exceeded the yields of continuous wheat after fallow by 58 per cent and 34 per cent. respectively.

Though it is difficult to understand, with the data available, why the increase in the hay yields was not proportionately greater than with the grain yields, these results support the view that the soil at Chapman is sadly deficient in nitrates, and that the benefits accruing from fallowing at this farm are mainly due to their production.

They further show that the fertility of these soils can be improved by a system of farming which supplies additional material—in the form of change crops fed off or ploughed in—upon which the forces set in operation by fallowing can operate to produce increased nitrates.

The importance of having an abundant supply of nitrates in the seed bed at sowing time, and the almost essential part which fallowing, under our conditions, takes in their production, is not sufficiently recognised at present. Even in districts with a much less liberal rainfall than at Chapman, this feature is of great importance, for a plentiful supply of nitrates not only assists in giving the young plant a good start, but enables the crop to make the best use of whatever moisture may be available for the crop during its growing period.

As the production of nitrates is dependent upon the humus content of the soil, it is important to maintain this in rich soils and to increase it in those of lower fertility.

No special effort is needed to increase the humus content of the fertile forest lands, as found at Merredin, but the good yields shown to be possible on such land with fallowing, whilst it is in good condition, prove the need for maintaining it. The tillage operations connected with cropping, and to a greater extent under a system of fallowing, by promoting increased oxidation break up and destroy its humus. The replacement of the humus so destroyed is therefore the great need in connection with the cropping of these soils. Our method of harvesting leaves the straw standing after the crop has been removed, and this stubble, if returned to the soil by being ploughed in, or as the result of being fed off will, as it or the residues decay, add to the humus content of the soil. The stubble, therefore, *unless burnt,* affords a very ready means of restoring, wholly or partially, the humus destroyed by tillage. It must be remembered, however, that the stubble takes time to decay, and if ploughed in there must be time for this to take place, for until it does decay the condition of the soil is unsuitable for the best results with wheat. If the crop is planted before the stubble is rotted, the yields will probably be less than if the straw were burnt.

Fortunately in this State the stubble has a feeding value, and so it can be fed off, thus doing away with the somewhat difficult work of ploughing it in. As it has a feeding value, economic farm practice demands that it be utilised. This also requires time, but no longer than to rot the stubble. It will, however, require that the season between the operations of cropping and fallowing be devoted to feeding off the stubble. It is therefore recommended that for the fertile forest lands, in districts of similar rainfall to Merredin, there be adopted the three-course rotation of:—

Fallow,
Crop,
Stubble.

In districts of more liberal rainfall a change crop for grain, hay, or grazing can be substituted on the stubble area as frequently as the practical arrangements for working the farm will permit.

The yields on the light land at Chapman, and with a liberal rainfall, show the definite need for fallowing, which would be even greater in a district with a lighter rainfall. The yields also show the need for improving

CHAPMAN EXPERIMENT FARM.

Wheat without Fallow, 1923.

Wheat after Fallow, 1923.

its fertility; further, the proportionate increases due to the inclusion of renovating change crops show how this can be done by increasing the quantity of humus-making material to provide for an additional production of nitrates. It is true that a deficiency of nitrogen can be supplied by means of commercial fertilisers, but unlike phosphoric acid in superphosphate, nitrogen is altogether too expensive to permit of the crop requirements in this direction being economically supplied by fertilisers. At the present rates the nitrogen contained in one bushel of wheat would cost 1s. if supplied by sulphate of ammonia, or 2s. 6d. if by blood.

The wheat farmer should secure the nitrogen necessary for his crops by the growth of renovating change crops, and made available by the practice of fallowing. The most suitable crops for this purpose are leguminous and deep rooting ones. When these or their residues are ploughed in the humus content of the soil is increased, and subsequently, as the humus decays, the nitrogen content also.

Unfortunately neither the legume, peas, nor the deep rooting rape have proved safe enough to be suitable for the conditions under which the experiments were conducted, and it is doubtful if they can be considered reliable for the major part of the wheat belt. The crop found to be most useful and reliable to date is the oat crop, and pending the discovery of a better one, it is therefore recommended that it be utilised for the supply of humus. Best results are obtained with it after a fallow, and as the object aimed at is to secure the maximum amount of humus-making material, it should be preceded by a fallow. The rotation therefore recommended at present for lands of low fertility, in districts either of light or liberal rainfall, is:—

Fallow,
Grain or Hay Crop,
Fallow,
Fodder Oat Crop (grazed).

SUMMARY.

1. Rape and Peas have given better results after fallow than without, but in these experiments have proved too uncertain to be recommended for general cultivation.

2. The Oat crop has been found to be the most reliable change crop for fodder and renovating purposes.

3. Fallowing has produced distinctly increased yields on fertile forest lands under a light rainfall.

4. Fallowing has proved beneficial also in controlling weeds, and for this purpose fallowing will be useful on fertile lands under a more liberal rainfall.

5. Fallowing has proved so beneficial on light soils under a liberal rainfall at Chapman that it is essential.

6. Fallowing will prove quite as essential for light soils with a lighter rainfall.

7. Fallowing is therefore necessary throughout the major part of the wheat belt to secure the safest, best and cleanest crops.

8. The yields on the fertile forest lands indicate no special need for the inclusion of a change crop, but the good yields obtained indicate the need for keeping them in good "heart."

9. To achieve this the stubble, or its residues, should be ploughed in, not burnt off.

10. The yields on light lands are distinctly benefited by the inclusion of a change crop for renovating purposes in the rotation. Such crops should be fallowed.

DEPTH OF PLOUGHING EXPERIMENTS.

The object of these experiments is to determine the comparative effects upon the resulting crops of ploughing at different depths. The depths ploughed were 4in., 6in., and 8in., to present respectively shallow, medium, and deep ploughing. At each farm all the plots were ploughed with a 4-furrow plough. At Merredin this has always been a disc, but at Chapman a mould board plough was used until 1921, since when the disc plough has been in operation. In each case the depth ploughed on any plot has been the same since the experiment commenced, that is, the plot ploughed 4in. in the first year has been ploughed at that depth each time the same series of plots have been used for the experiment. The subsequent cultivation, the seeding, the kind and quantity of fertiliser, and the method of harvesting were the same for all the plots, the only variation being the depth of ploughing.

The varieties used prior to 1921 were: at Chapman, "Comeback"; at Merredin, "Federation." "Nabawa" has been used at both farms since then. The fertiliser used has been superphosphate, containing 17 per cent. water soluble phosphoric acid in 1919-1922, and containing 22 per cent. in 1923. The quantity applied was 80 to 90 lbs. at Chapman during 1919-1922, and about 95 lbs. in 1923. At Merredin the amounts were about 70 and 85 lbs. for the same period. The planting at both farms was carried out during May, but later in the month at Chapman than at Merredin.

The results computed to acre yields, and also as percentages of the yield from ploughing to a depth of 6 inches, are shown on the table herewith.

The figures representing the percentage yields afford an easy means of comparison. From these it is seen that considerable fluctuations occur from year to year. At Chapman the average results show a very slight difference in favour of the deeper ploughing. The difference is so slight that it cannot be regarded as very significant. They, however, indicate that the deeper working and consequent aeration has resulted in a greater amount of plant food being made available with consequently better yields.

At Merredin the average results show that the shallow ploughing is quite as effective as the deep, and the latter has no detrimental effect upon the yield. In that district, with a fertile forest soil, it is evidently more important to plough or cultivate thoroughly than deeply.

DEPTH OF PLOUGHING EXPERIMENTS.

CHAPMAN EXPERIMENT FARM.

Year.	Hay Yield.						Grain Yield.								
	Ploughed 4in. deep.		Ploughed 6in. deep.		Ploughed 8in. deep.		Ploughed 4in. deep.			Ploughed 6in. deep.			Ploughed 8in. deep.		
	cwt. qrs. lbs.	%	cwt. qrs. lbs.	%	cwt. qrs. lbs.	%	bus. lbs.	%		bus. lbs. Yield	% lost		bus. lbs.	%	
1914	17 1 12	99	17 2 8	100	20 1 4	115									
1915	16 2 24	122	13 2 24	100	20 2 0	149	11 25	95		12 0	100		11 33	96	
1916	24 3 20	97	25 3 20	100	29 0 8	112	12 13	93		13 7	100		13 33	103	
1917	25 2 24	99	26 0 0	100	26 2 24	103	10 51	98		11 7	100		11 7	100	
1918	20 0 16	92	21 3 4	100	19 2 16	90	13 17	106		12 29	100		12 24	100	
1919	32 2 16	109	30 0 0	100	35 2 24	119	20 29	98		20 56	100		23 12	111	
1920	17 3 12	80	22 1 20	100	21 1 4	95	11 20	93		12 11	100		not available.		
1921	21 0 16	95	22 0 8	100	23 1 4	106	15 33	95		16 27	100		16 13	99	
1922	38 0 0	101	37 2 8	100	32 2 8	87	26 16	107		24 32	100		22 45	93	
1923	28 0 16	114	24 2 24	100	24 2 8	99	20 24	102		19 55	100		21 36	108	
Average	**24 1 2**	**100**	**24 0 21**	**100**	**25 1 12**	**105**	**15 45**	**99**		**15 52**	**100**		**16 33**	**104**	

MERREDIN EXPERIMENT FARM.

1915	52 0 24	98	53 0 24	100	52 1 20	99	25 18	95		26 38	100		25 30	96	
1916	45 2 16	119	38 1 4	100	33 2 8	88	12 0	119		11 1	100		12 51	117	
1917	67 2 16	106	63 3 20	100	66 3 12	105	29 25	103		28 40	100		22 20	102	
1918	49 1 4	96	51 1 12	100	56 1 4	110	24 14	104		23 12	100		22 45	98	
1919	48 2 0	111	43 3 12	100	46 2 8	106	25 34	107		23 54	100		26 16	110	
1920	58 2 16	129	45 1 12	100	55 3 14	123	27 58	112		24 54	100		25 18	102	
1921	47 1 20	95	49 3 4	100	54 1 20	102	20 13	102		19 46	100		19 38	99	
1922	31 2 9	94	33 2 19	100	33 0 12	98	19 28	100		19 23	100		17 30	90	
1923	51 0 0	107	47 2 8	100	48 3 4	103	27 49	96		28 59	100		29 25	102	
Average	**50 0 24**	**106**	**47 1 4**	**100**	**50 0 0**	**106**	**23 33**	**103**		**22 58**	**100**		**23 9**	**101**	

CULTIVATION OF THE POTATO.

G. N. Lowe,
Senior Potato Inspector.

SEED : ITS SELECTION AND TREATMENT.

Seed and its selection is certainly the most important phase of potato cultivation, because without good seed, no matter what care and attention has been given to the preparation of the soil and to the planting, it is useless to expect a full crop.

Inexperienced growers, particularly, are often tempted by reason of good prices to dispose of the very tubers that should be retained for seed, keeping back for this purpose the small, miserable stuff that would more profitably be used to line "the gintleman as pays the rint."

The same growers who also are stock owners would of course not apply the same principle to the breeding of their animals, but would be careful to sell off the poor ones and breed up from their best. It is not just pure luck that Melba XV., the world's champion cow, produced 1,638 lbs. of butter fat during her lactation period, or that the world's champion hen laid 339 eggs in 365 days. Such records are only obtained by systematic and careful selection and breeding: and so with potato growing—only the maximum can be expected where the highest class seed is used.

Quite a number of new arrivals will this winter plant their first crop of potatoes, and with them it will be necessary to buy seed with which to get a start. In this case the best procedure is to obtain their supplies—allowing at the rate of about 10 cwt. per acre—from a reputable grower who is making a success of the business, and endeavouring, if possible, to see the crop from which the seed is offered in the course of digging. Some very fine seed is available at present which has come under the Potato Inspection Branch's newly initiated Certified Potato Seed Scheme, and inquiries for this or other seed at any time will be always gladly replied to.

It will be found that the "Delaware" variety is suited to practically every crop and class of soil in Western Australia; indeed it is now grown almost solely. The seed which is grown in Benger Swamp will also be found to give better results than "redsoils." The reason for this is probably due in a large measure to the distinct change from the blue friable clay there to red loams in which are generally planted the winter crop.

Whilst it is desirable to plant potatoes which are sprouting, the "Delaware" may quite safely be used without. In fact in the older potato districts, such as Benger, Brunswick, Roelands and Burekup, the whole of the June-July planting goes on without any of the seed showing a sign of sprouting or buds.

Points to remember in choosing seed are that the variety should be true to name, free from disease both outward and inward, and from a heavy yielding crop taking the season into consideration. It is a wise precaution to cut some of the tubers offered, and if discolouration or brown spots are noticeable in the flesh to discard them. Skin diseases are of course more readily noticed.

Of course the most desirable type of seed is that which is guaranteed as only from selected heavy yielding roots; but so far the writer knows of no grower who has such seed to sell. Any grower who goes in for this system invariably selects only enough to plant his own "stud" plot to provide for his own requirements, but once the new grower becomes established this system should be closely followed by him to at least provide for his own area.

The method to follow is to save the roots at digging time which produce five or six shapely "saleables" and upwards; and by continuing this plan regularly, even in a bad season, the resultant crop will quite reasonably be much heavier than from the usual type of seed.

Where a grower only plants the winter crop, due to having no summer land, it will be necessary for him to go in for a late variety such as the "Factor" to enable him to hold the seed from crop to crop; but even with this long-growing potato difficulty will be experienced in holding the seed successfully for such a long period.

In such a case it is really preferable to purchase "Delaware" from a reliable source each season. Should it be found necessary to hold seed for a long period, the method to check the growth of long, weakly "shoots" is to spread the tubers thinly on the floor of a shed or, better still, on racks of timber and wirenetting, and to have these stacked in tiers in the light but, of course, not where the sun is likely to cause damage.

This system enables the grower to go through his seed regularly to pick out any undesirable tubers, and has the effect of producing "greening" by the action of light on the potato juices, with consequent strong, chubby buds. Such seed will always give a more regular germination in the field, due to the hardening of the "sett."

For the grading of seed—and regular attention must be paid to this—a very handy arrangement is a sloping table with slatted bottom. Where any quantity of seed has to be handled much time can be saved and the work completed more easily by this means.

Seed potatoes, probably unlike any other class of seed, should, to give maximum results, be dug immature, that is before the plant has reached the ripe stage, when the top has died down. Why such tubers should yield better has never been satisfactorily explained, but repeated tests have established this. Trials conducted over a period of years in Great Britain and America show that the difference in favour of immature seed is slightly over 2 tons per acre.

Seed for spring and winter planting should invariably be cut, although in other countries this practice is not general. However, where a grower is planting a "stud" plot regularly, and using the heaviest producing roots for his seed, not to cut such tubers would be a costly business, apart from which the "setts" of about 2 ozs. in weight will give better returns.

The cutting of the potato will in itself produce a quicker germination, as the injury threatens the life of the plant and gives rise to an effort to quick reproduction. This tendency will be noticed when a potato has been stabbed with the fork at digging time and bagged up with uninjured produce.

In order to have the germination uniform, then, it is necessary, where seed about the size of a hen egg occurs amongst large seed, that a portion of the stem end should be chipped off.

Provided the small tuber is from the same vigorous heavy producing strain, not a great difference will be found in the resultant crop. Actually the return is best from large tubers from a heavy cropping root, and next from the small ones from this. Next in order come the large tubers from a poor root, and finally the small ones. It is hardly necessary, therefore, to point out the fallacy of using such seed as the latter.

(To be continued.)

Seasonal Notes.

With the fine rains just experienced the plough should be kept busy in the potato paddock, if fallowing has not been the practice.

Weeds are beginning to spring, and must be put where they are useful—under the sod.

Set out "lands" of not more than 11 yards wide (less in wet localities) to allow of free drainage.

Buy seed now if not producing your own. Good seed, free from moth infection, is difficult to obtain, as this pest was very prevalent in the crop just dug.

Refer to the Potato Branch for the names of reliable growers.

Be prepared to pay a good price for good seed if you have to buy.

Carefully go through seed saved and discard any showing signs of disease or malformation.

Dip seed now in Corrosive Sublimate solution at a strength of 1 to 1,000 or 4 ozs. to 30 gallons, and again 10 days before planting if the seed be not shooting. Dipping will practically prevent scab and "rosette."

Fallow and clean cultivation prevents "earth mite" (so-called red spider), slugs, and other pests.

ROYAL SHOW WHEAT PRIZES.

The attention of intending competitors is drawn to the fact that the last date of entry for the Royal Show Wheat Prizes has been extended to June 30.

For the purposes of this competition the State has been divided into three zones, and in each zone prizes of £3, £2 and £1 respectively are offered for the best bag of Australian strong wheat, and also for the best bag of Australian premier strong wheat, thus making six prizes in each zone.

The milling of these wheats for judging is done by the Government Chemical Branch, and the judging by a practical miller, the Government Chemist, and the Director of Agriculture (Mr. Geo. L. Sutton).

The exhibitors in this section are also competitors for the "Sunday Times" silver cup, value £10 10s., which is awarded to the best bag of wheat exhibited.

PEAS AND THEIR CULTURE.

H. D. LARWOOD,
Potato Inspector.

PEA.

(*Pisum sativum.*)

The pea is an annual, probably a native of Central Europe or the mountainous region of Western Asia. The majority of garden peas have a white flower, while that of field peas is violet coloured. The plant is a hardy one and resists frost, though very heavy frost will check it, especially about flowering time. Very dry heat is not conducive to heavy cropping except in moist situations, and on this account the plant is difficult of production during a hot dry summer, especially between December and April. The pea thrives best when planted during the autumn, winter, and spring seasons if planted in suitable soil, during which period success is easily assured, but if the planting is done during the summer months failure is the common result. Though the pea is essentially a cool season or winter plant it can, however, be raised with some measure of success during the summer in wet, well-drained swamp land.

Selection of Soil.—A good rich loam is the ideal soil, but there is hardly a plant-producing soil which will not give encouraging results if the seed is planted at the right time and suitable varieties chosen.

Notwithstanding that the plant withstands frost, a sufficient amount of warmth is needed to ensure rapid growth, and consequently for early peas planted during April and May a warm situation not exposed to heavy winds should be selected. Hillsides having an eastern aspect are particularly favourable for this purpose. The soil must be friable and light. For the main crop, sown during June and July, a somewhat flatter aspect can be planted with safety, but for late peas, planted between August and December, a soil which retains the moisture must be selected. By making use of these varied situations where available a succession of crops can be harvested during almost every month in the year.

Culture.—The gardener should carefully study the moisture-retaining capacity of the soil. During May, June, and July, which are our wettest months, the land selected should be friable, porous and well-drained, while for summer planting moist well-drained land only should be used. A careful study of the soil should therefore be made before planting, and the method best adapted to it and the time of the year brought into operation. The seed should be planted about two inches deep during the winter months and from three to four inches during the summer, regulating the depth of planting according to the soil and the moisture. With an assurance of permanent moisture, however, even an inch is sufficient to promote germination. The land must be ploughed fairly deep and thoroughly harrowed, and care taken that it is drained during the winter months. During the winter it is not desirable that the surface should be worked to a fine mulch. Surface water is removed by evaporation, and the surface is prevented from forming

into a crust if a coarser condition is retained. The plant is hardy, a strong grower, and has a large seed which makes a vigorous shoot. Sow in drills about two feet apart for dwarf varieties and two feet six inches to three feet apart for the taller varieties. Successional sowing in the open can be made all through the winter and spring provided the land is well drained during the winter and sufficient moisture is reserved in the soil during the spring and summer. A plot should be sown about every three weeks. Sow one and a half bushels per acre, or in the garden plot an inch apart.

For early planting sow William Hurst or American Wonder. These varieties require about 13 weeks from sowing to picking. Yorkshire Hero is a good main crop variety, taking about 15 weeks. These three varieties are used chiefly by market gardeners. The dwarf peas mentioned will not require staking, but the Yorkshire Hero and taller varieties will be considerably improved if staked. The stakes support and give the plant an upward tendency.

The method adopted in planting large areas is to thoroughly plough the land, drawing out furrows about 30 inches apart, with the plough set about three inches deep. Apply the manure in the furrow, sow the seed, and then harrow the land thoroughly both ways, thereby covering the seed about two to three inches deep. An important point, if artificial manure only is to be used, is to apply the manure in the furrow and then thoroughly stir it with a pronged stick or fork hoe, so as not to allow the seed to come into direct contact with the fertiliser, otherwise the seed may decompose and not germinate.

VARIETIES.

William Hurst.—Dwarf, wrinkled, very compact growth, heavy cropper, fine quality, very sweet, large dark green well-filled pods. The leading dwarf pea with market gardeners.

American Wonder.—Resembles William Hurst. Ripens about a week later. Good bearer, fine quality and early.

McLean's Little Gem.—Very dwarf, wrinkled, productive and very early.

Yorkshire Hero.—Two or three weeks later than dwarf, most popular for main crops, strong grower, large well-filled pods, lighter green than William Hurst, pods keep well, requires staking if possible.

Stratagem.—Very strong grower, large very showy pods, large peas of good flavour, not usually a good selling variety, has a large husk, must be staked.

Daisy.—Similar to Stratagem, but not so tall, usually fine looking pods, large peas of good flavour, a good main crop variety.

Laxton's Gradus.—A good main crop variety 2½ to 3 ft. high, strong grower, curved long green pods. This is the earliest of the main crop varieties, and is notable for its great size and appearance of its pods.

Telephone and Duke of Albany.—Late, very productive, strong growers, requiring stakes at least five feet out of the ground, very prolific, big long pods, and grown mostly for show purposes.

MANURING.

For good loamy soils use:—

Bonedust	3 cwt.
Superphosphate	5 cwt.
Sulphate of Potash	4 cwt.

Mix thoroughly and apply at the rate of 3 cwt. per acre.

For light sandy loam use:—

Bonedust	3 cwt.
Superphosphate	5 cwt.
Sulphate of Potash	4 cwt.

Mix thoroughly and apply at the rate of 3 cwt. per acre, and top dress the land when crop is about 6 to 8 inches high with one cwt. of Sulphate of Ammonia per acre.

For Sandy Soils.—The crop will be considerably improved if a good dressing of well rotted stable manure is distributed along the furrow about 3 inches deep and a liberal dressing of artificial manure, as recommended for light sandy loam, applied, with the top dressing of Sulphate of Ammonia. The Sulphate of Ammonia should be applied before the crop is hilled up. The hilling can be done either by hand or with a horse cultivator or scarifier, by removing the ordinary cultivating tines and securing the moulders.

FIELD PEAS.

Peas may also be sown broadcast for drying purposes or ploughing in to enrich the soil, or for fodder. The land will need to be thoroughly ploughed and harrowed, manured the same as for garden peas, and the seed harrowed in.

If the soil is friable and in a good moist condition the surface will be well loosened and able to receive considerable rain without baking.

Varieties.

Dunn's Field, Blue Field Pea, The Partridge and Small White.

SUGAR OR EDIBLE-PODDED PEAS.

This class of pea is coming much into favour. It differs from the ordinary garden pea in that the pod, instead of developing a stringiness of the husk when ripe, retains its tenderness and can be eaten whole.

The tall climbing varieties are also much in favour. Of special merit are the Forty-day edible-podded pea and Saint Desirat.

Two popular semi-dwarf and dwarf varieties are Early Brittany Sugar and Dwarf French Sugar.

Plant, prepare and manure land same as for ordinary garden peas.

BROAD BEANS

(*Faba vulgaris*).

This bean is essentially a winter bean, and finds a welcome place in almost every household. Our soils lend themselves admirably to the culture of beans, and the broad bean especially. Sow seed about 4 to 6 inches apart in rows 3 feet wide. Plant seed 2 to 3 inches deep, and manure same as for garden peas. Sow on sandy soils during April, May and June, and on loamy and swamp soils during June, July and August.

Varieties.—Early Long Pod and Broad Windsor.

Broad beans will withstand a certain amount of frost and grow luxuriantly, attaining a height of about 4 or 5 feet. In some localities it is desirable to nip out the top of the plants after heavy flowering, which assists in the setting of the fruit. The plant is strong and erect and does not require staking.

GARDEN NOTES.

JULY.

Plant the following seeds in beds for transplanting:—

Onions.—White Queen, Silver Skin, Early Bartletta (White), Brown Spanish, Brown Globe.

Cabbage.—Henderson's Succession, Large White Brunswick, St. John's Day, and East Ham.

Cauliflowers.—It is getting too late for planting seeds of these.

Leeks.—American Flag, London Flag.

Lettuce.—New York and Neapolitan.

Parsley.—Double Curled Green.

Transplant:—Onions, Leeks, Cabbage, Brussel's Sprouts, and Lettuce. Plant in the open:—

Turnip.—Purple Top White Globe, Snowball, White Stone, Strapleaf.

Swede Turnip.—Skirving's Purple Top, Mammoth, and Monarch.

Carrots.—James' Intermediate, Long Red Altringham, Early Horn, and Ox Heart.

Parsnips.—Hollow Crown, Guernsey, and The Student.

Beetroot.—Egyptian Turnip Rooted, Eclipse, and Long Red Erfurt.

Kohlrabi.—Green or Purple.

Potatoes, only where freedom from frost.—Delaware, Early Vermont, Early Rose, Carmen, Manistee, Bruce, Manhattan, and Beauty of Hebron.

Peas.—William Hurst, American Wonder, Yorkshire Hero, The Daisy, Stratagem, and Laxtone Gradus.

Beans.—Broad: Early Long Pod, Broad Windsor. French: Only where freedom from frost is assured. Dwarf: Canadian Wonder, Pale Dun, Negro Long Pod. Climbing Varieties: Kentucky Wonder, The Epicure, and White Dutch.

Spinach and Silver Beet.—Round and Viroflag.

Tomatoes.—Large Red Earliana and Chalk's Early Jewel.

AUGUST.

Same as for July, and also make early sowings in hot bed or under glass frame of:—

Cucumbers.—Long Green Prickley, Extra Long White Spine.

Pumpkin.—Turk's Cap, Iron Bark—Triamble, The Nugget, and Button, Crown.

Vegetable Marrow.—Long White Bush, and Custard Marrow.

Tomatoes.—Wrinkled varieties: Large Red and Market Favourite. Smooth skins: Chalk's Early Jewel, Spark's Earliana.

Sow in beds in the open:—

Celery.—Henderson's White Plume.

Asparagus.—Conover's Colossal.

SEPTEMBER.

This is usually our spring month.

Sow—Turnips, Beet, Parsnips, Carrots, Cabbage, Tomatoes (Chalk's Early Jewel, Earliana, Burwood Prize, Reward, Trophy, Mikado, and Ponderoso. The last mentioned should be grown for home use only; it is too large for marketing purposes.) Vegetable Marrow, Pumpkin, Turk's Cap, Ironbark, and Bugle or Trombone.

STICKFAST FLEA.

A preventive method which has proved satisfactory is to floor all roosting houses with movable floors and remove all droppings at least twice weekly, occasionally lifting floors and giving a light spraying of kerosene. Fleas will not thrive in heat and light. By having portable houses and shade, removing these once weekly to spots that have been exposed to sun, and spraying lightly with kerosene the space previously occupied by house and shade is also very effective. The Poultry Inspector (Mr. R. A. Dusting) instances two poultry farms that, two years ago, were so badly affected with flea that the owners seriously contemplated going out of business, but by using the above methods during last summer they were practically rendered immune and did not have to handle a single bird.

In autumn, when fleas appear most active, if yards can be kept well soaked with water this will prove effective, but owing to the prevalence of chicken pox and roupy colds at this period it is not advised, as damp yards are conducive to the above complaints. Cleanliness and regularity in removing droppings are the main factors in keeping this pest under control.

WESTERN AUSTRALIA—DEPARTMENT OF AGRICULTURE.

List of Bulletins available for Distribution.

No. 20.—"The Pruning of Fruit Trees." By J. F. Moody. Price 2s. 6d.
No. 46.—"Fruit Packing and Marketing and Exporting of Fruit." By J. F. Moody and J. Ramage. Price 1s. 6d.
No. 47.—"The Poultry Keeper's Manual." By G. Allman. Price 1s.
No. 83.—"Horticulture and Viticulture." By A. Despeissis. Price 2s.
No. 5.—"Fruit Drying." By J. F. Moody. Free.
No. 15.—"Root Rot." By A. J. Despeissis. Free.
No. 24.—"Hints to Stock Breeders" (revised). By R. E. Weir. Free.
No. 41.—"Irrigation and Drainage." By A. H. Scott. Free.
No. 49.—"The Feeding of Horses." By Professor Paterson and G. L. Sutton. Free.
No. 57.—"Vermin Destruction." By A. Crawford. Free.
No. 60.—"The Farmer's Clip." By J. J. Mahood. Free.
No. 68.—"Flaying and Treatment of Hides." By R. E. Weir. Free.
No. 72.—"The Potato: Its Cultivation, Pests and Diseases." By G. N. Lowe, L. J. Newman, D. A. Herbert. Free.
No. 73.—"The Success of Dairying in W.A." By P. G. Hampshire. Free.
No. 74.—"Tobacco Growing: Notes for Intending Planters." By G. W. Wickens. Free.
No. 79.—"Sheep on the Wheat Farm and their Management in W.A." By H. McCallum. Free.
No. 81.—"The Improvement of Pastures." By E. A. Mann and D. A. Herbert. Free.
No. 84.—"Tomatoes: Their Culture in W.A." By H. D. Larwood. Free.
No. 86.—"Notes on Fertilisers." By P. G. Wicken. Free.
No. 87.—"Sheep Feeding Experiments: State Farm, Chapman, 1920." By G. L. Sutton and F. Vanzetti. Free.
No. 88.—"Light Land: Conference." By G. L. Sutton. Free.
No. 90.—"Stock Waters: Standard for Composition of." By E. A. Mann. Free.
No. 93.—"The Home Tanning of Sheep and other Skins." By H. Salt. Free.
No. 94.—"The Dingo." By B. W. Leake. Free.
No. 95.—"The Stickfast Flea." By L. J. Newman and Geo. Allman. Free.
No. 96.—"Poison Plants of W.A." By D. A. Herbert. Free.
No. 99.—"Australian White." By G. L. Sutton. Free.
No. 101.—"Cotton Cultivation." By G. L. Sutton. Free.
No. 103.—"Kerosene Method for Eradicating Zamia Palm." By G. K. Baron-Hay. Free.
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